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# AGRICULTURAL ENGINEERING

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## MARCH 1931

Cotton Harvesting Development Up-to-Date - - - - - - - - - - - *H. P. Smith*

Ultra-Violet Light in Poultry Production - - - - - - - - - - - - *L. C. Prickett*

Developing the Right Attitude Toward Farm Building Design *H. E. Wichers*

Opportunities for Agricultural Engineering Research - - - - *R. W. Trullinger*

Combination Cushion Spring and Clutch Release Hitch - - *E. G. McKibben*

Corn Production Study with the General-Purpose Tractor - - *R. U. Blasingame*

VOL. 12 NO. 3

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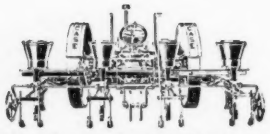

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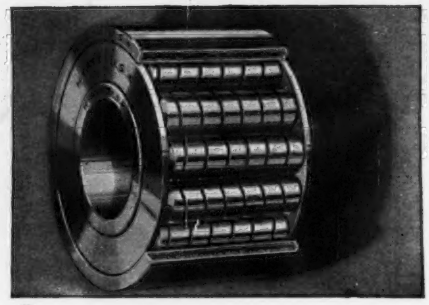

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AGRICULTURAL ENGINEERING

Vol. 12 MARCH, 1931 No. 3

# Cotton Harvesting Development to Date[1]

By H. P. Smith[2]

MEN, women, and children of all races, who have had to spend long, weary hours picking cotton by bending their backs or crawling along on their knees, have no doubt fervently wished for a machine that would relieve them of this laborious task. To make this wish come true hundreds of men have given thought, time, labor and money trying to invent a machine to pick cotton successfully. Several large implement manufacturers have special engineers assigned to the task of developing a cotton harvesting machine. Other smaller manufacturers, private individuals and experiment stations are also trying to make a machine to harvest cotton economically. Millions of dollars have been spent and other hundreds of thousands of dollars are being added each year in the attempt to solve the problem.

Almost every conceivable device has been tried with varying degrees of success. These can be divided into two distinct divisions:

1. Those mechanical devices that strip the cotton from the plants either before or after frost.
2. Machines designed to gather the open cotton at any time during the season without injury to the rest of the plant.

Harvesting by the stripper method first came into prominence in 1926 when several hundred thousand bales of cotton were harvested mostly by homemade strippers throughout the panhandle of Texas and Oklahoma.

Some authorities say that the first attempts to harvest cotton by mechanical strippers probably were made in West Texas in 1914, and consisted of stripping the bolls from the plants by use of a picket fence. The pickets were held together by several strands of wire. When the fence was pulled by a team across the cotton rows, cotton, burrs and bolls were stripped off leaving only the main stalk and large branches.

Another version is that a Norwegian farmer produced a very large crop of cotton and was unable to obtain labor to pick it. Not to be done out of the profits of his year's work, he mounted a large box on a sled and while his wife drove the team attached to the sled down the cotton rows, the farmer used an ordinary cotton seed fork to strip the plants of their fleecy burden; he simply forked the cotton into the box.

From 1914 to 1926, and from 1926 to the present, the development of cotton strippers has been rather slow and they have been used in a rather limited way. Their wide use in 1926 directed attention to the possibilities of stripping (commonly called "sledding"), and as a result several machines have been developed that do a remarkable job of getting the cotton.

Generally strippers can be divided into two classes: The homemade or those made in local blacksmith shops, and the commercial strippers. There are two homemade types, the finger and the slot. (A full description of their construction, operation and economical use is given in Texas Station Circular No. 52 "Mechanical Harvesting of Cotton in Northwest Texas.")

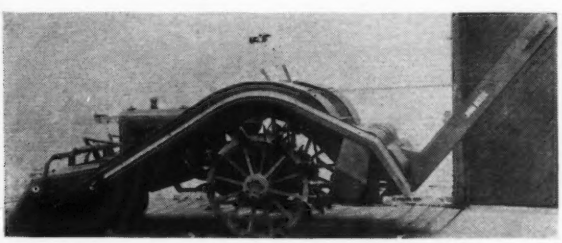
The sled, for the purpose of harvesting cotton, is far from perfection; in fact, it is an extremely wasteful operation, the use of which would not be tolerated under other than the peculiarly complex conditions which gave occasion for its inception.

Since 1926 there have been at least three manufacturers experimenting with cotton strippers with the idea of ultimately placing them on the market. During 1930 two of

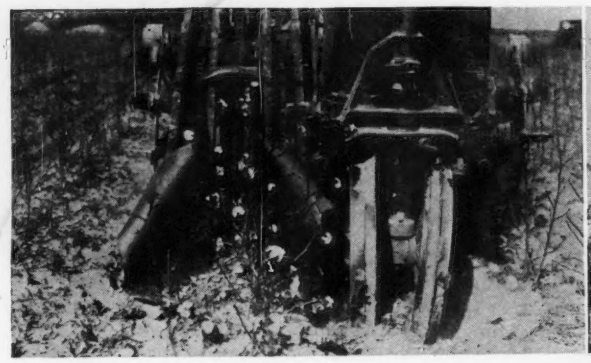
[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1930.

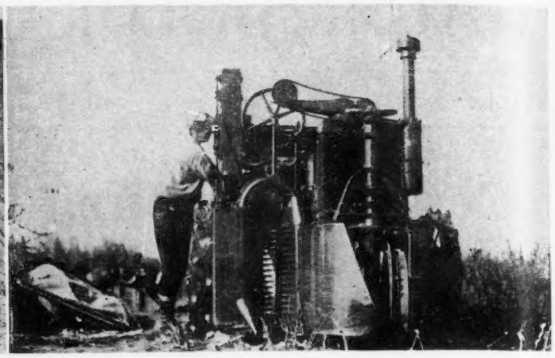
[2]Chief, division of agricultural engineering, Texas Agricultural Experiment Station. Mem. ASAE.

A homemade finger type cotton sled or stripper such as is used in Texas and Oklahoma



The Deere two-row cotton stripper





(Left) Front view of the cotton stripper being developed by the Texas Agricultural Experiment Station. (Right) 1930 model of the single-cylinder cotton picker developed by the International Harvester Company

these companies have gone into production with their cotton strippers, and one of them has gone so far as to manufacture about 250 machines representing a value of approximately $200,000.00. About the middle of October they claimed to have sold about one-half of these machines. Each of the three strippers that have been developed by manufacturing concerns operate on different principles.

The International Harvester Company has developed a stripper that can be attached to an ordinary corn binder frame and used as a horse-drawn affair, or it can be mounted on the Farmall tractor, one unit on either side, so that two rows can be stripped at the same time. Their stripping device consists of a chain having lugs or fingers made mostly of rubber, the tips of which overlap each other in the throat between two divider boards. As the machine moves forward the plants are stripped between these fingers, which retain the cotton bolls, carry them back, and deposit them in a box at the rear. To prevent plants being pulled up and sections of branches being pulled off, two rubber rolls have been mounted below the rubber fingers and revolve in such a way that they will pull the stalk or branches on through, even though they may pull or break off the stalk.

Deere & Company has also developed a horse-drawn stripper and a two-row outfit mounted on a general-purpose tractor. Their stripping unit consists of two metal rolls studded with short pins to strip upward on the plant as the machine moves forward along the row. As the cotton is stripped from the rolls by stationary plates, it falls into a conveyor trough where it is conveyed back to a hopper mounted on the rear of the machine.

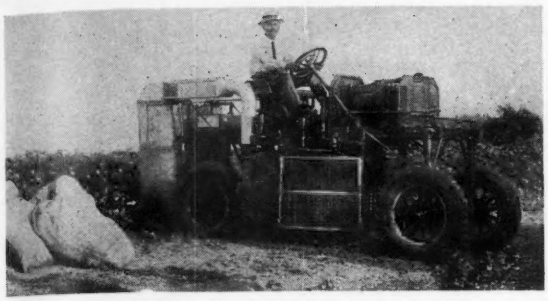
The other machine that is available is produced by the cotton harvester department of the Forth Worth Steel and Machinery Company. This machine is termed by the company as a "cotton combine." The stripping unit, however, resembles very closely that of the homemade sled, since it consists of six metal fingers approximately 3½ feet long and spaced ¾ inch apart, to strip the cotton from the plant. It, however, has a carrier chain with lugs extending inward from both sides over the fingers to drag the cotton back into the cleaning unit which is mounted to the rear. This machine not only harvests the cotton, but extracts the burrs and cleans the cotton at the same time.

The Texas Agricultural Experiment Station is also working on a cotton stripper which is somewhat similar in principle to that of the Deere stripper. Rubber rolls made of radiator hose have been substituted for the metal rolls with pins.

Our work started in 1927 when an attempt was made to convert an old row binder into a cotton stripper. This, however, when tried out on Brazos bottom cotton, did not prove a success. In 1928 two homemade sleds patterned after West Texas types, and a McCormick-Deering stripper mounted on a row binder were used to strip 1/16 acre of 12 different representative varieties. During the same year Deere & Company gave our institution one of their first experimental machines. We stripped a half bale of cotton with this machine during the fall of 1928. In 1929 we got some new ideas and decided to make some changes. Rubber rolls were substituted for the metal with pins; the rolls were made longer; one roll was made movable; additional pick-up fingers were constructed; and the bearing support at the rear end of the rolls was arranged so that they could be raised and lowered to change the angle of the rolls. The cotton was removed from the rubber rolls by a close fitting metal plate extending their full length. This machine was also arranged to drive with the power take-off from the Farmall tractor. The machine was drawn behind the tractor. This principle seemed to be wrong and in 1930 we constructed a new frame and mounted it on the side of a Farmall tractor so that the pick-up fingers and stripping unit would first come in contact with the cotton plant, thus preventing cotton being knocked off by the tractor as it moved over the plants.

With the 1930 model we were able to get and save from 89.5 to 96.3 per cent of the cotton off the plants, the amount varying with the variety. Where we lost the most cotton was on the lower 17 inches of the roll where it was necessary to install a stationary stripper plate. The cotton fiber seemed to adhere to the roll and was pulled and wedged in between the roll and the stripper plate, thereby having a ginning effect on the cotton. The upper part of the roll was cleaned by a revolving brush made of gin brush sticks. These worked so well that we thought a perfect cylindrical brush about 2 inches in diameter installed the full length of the roll would enable us to eliminate the stripper plate on the lower end, but when these cylindrical brushes were installed we found that the cotton fiber adhered to them so badly that they pulled the cotton locks on around and dropped them on the ground. Therefore, the present problem is to remove the cotton from the stripping roll and deflect it over into the conveyor so that it will not be dropped on the ground. With these rubber rolls we have stripped cotton with full foliage, and after the machine had passed down the row we had to look rather closely to pick out the row the machine had gone over in so far as the amount of foliage removed was concerned. This fact leads us to believe that stripipng can ultimately be done before frost with fair results. With a cleaner to remove green leaves early stripping of cotton could be practiced.

After observing the different strippers operate and trying to analyze the fundamentals upon which a machine of this type should work, and after conferring with other research engineers, the concensus of opinion seems to be that certain fundamentals in harvesting and cleaning cotton by the stripper method are essential. (I am in-



The Berry cotton picker

debted to V. F. Bozeman, of Deere & Company, for outlining these fundamentals.) They are as follows:

1. To get the maximum amount of cotton.
2. To extract the maximum amount of trash with a minimum loss of cotton.
3. To handle and clean the cotton with the least possible injury to the fiber.
4. That the separation of the cotton from the foreign matter shall start as early as possible in the process of harvesting.
5. That the cleaned cotton or semi-cleaned cotton shall not come in contact with cotton that has been cleaned to a lesser degree.
6. That the cotton be kept in a fluffed condition and not be wadded so as to avoid unduly mixing the foreign matter with the fiber, and to keep from twisting or tangling the cotton and cause machining.
7. That the foreign matter be crushed or machined to the minimum and remain in as large particles as possible and extracted in as nearly a natural condition as possible, thus avoiding mixing unnecessarily the foreign matter with the fiber.

## DEVELOPMENT OF PICKERS

Even though the stripping method of harvesting has attracted more attention in the past few years than that of harvesting by machines that pick the cotton, we find that there is more money, time and effort being spent today in trying to develop the latter type of machine than ever before. Most people believe that the stripping method is adapted only to possibly the sub-humid regions of northwest Texas and Oklahoma, and consequently they feel that to take care of the harvesting of cotton in the greater part of the cotton belt they need a machine that will pick the cotton early in the season when there may be lots of foliage and unopened green bolls still on the plant yet not injure the stalk or any part of the plant.

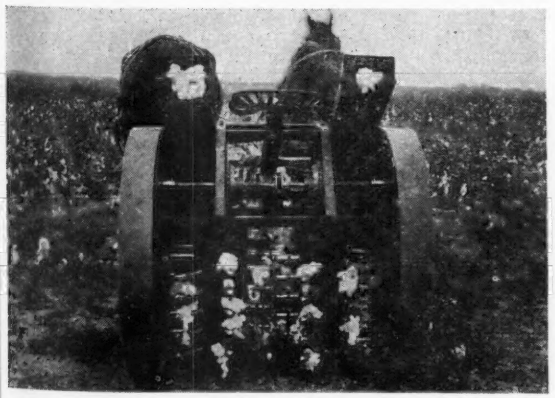
We find that the first attempt, as near as can be determined, to develop a cotton harvester was by S. S. Rembert and J. Prescott of Memphis, Tennessee. These men were granted a patent on a cotton harvester on September 10, 1850. It was equipped with both picking cylinders and picking disks, the cylinders being placed on vertical shafts while the disks were on horizontal shafts. They had a wonderful vision in mind since they incorporated in their patent claim that "our cotton picking machine may be multiplied and extended to such a width as to embrace several rows of cotton plants at once".

Apparently the next attempt was made by Geo. A. Howe of Brooklyn, New York, who was granted a patent in 1855 on a hand-operated cotton picker. This had to be carried under the left arm while the right hand operated a crank to run a toothed chain which seized the cotton and conveyed it back to the rear where it was stripped off and dropped into an attached bag.

During the years that have followed numerous other men have tried their hand at developing a cotton harvester. One of the most outstanding of these men was August Campbell. He was granted his first patent July 16, 1895. This was assigned to the American Cotton Picker Company of Chicago. Later he apparently moved to Pittsburgh, Pa., where from 1901 to 1907 he appled for and was granted several other patents on cotton harvesters, one covering a cotton picker spindle. These were assigned to the American Cotton Picker Company of Pittsburgh. In 1912 we find a patent being granted to B. C. White and A. Campbell of Woonsocket, R. I., and assigned to the Price-Campbell Cotton Picker Corporation of Wilmington, Delaware.

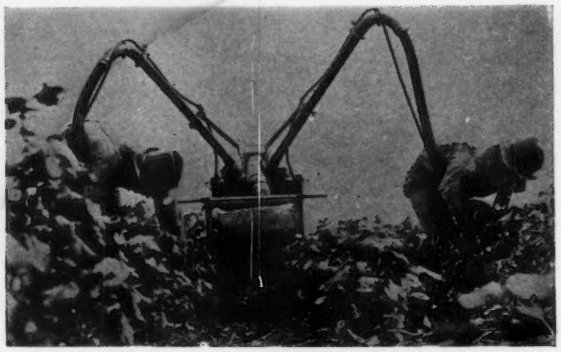
I also find that T. H. Price had been granted patents on a cotton harvester as far back as 1904 and assigned to the Utility Cotton Picker Company of New York. Therefore, it appears that Price and Campbell joined in forming the Price-Campbell Cotton Picking Corporation a short time prior to the granting of the patent of 1912. They apparently interested J. A. Kemp of Wichita Falls, Texas, who at that time was interested in manufacturing a motor truck and got him to go in with them and form the Mechanico-Agricultural Company for the purpose of manufacturing the Price-Campbell cotton picker. The company, however, was not a success. Two or three years afterwards the International Harvester Company acquired the patent rights held by this organization and have since developed and refined this machine into the present cotton picker units that they now have mounted on their Farmall tractor. Only a couple of weeks ago I had the privilege of witnessing tests of the latest developments of this machine which now weighs only a few hundred pounds in comparison with the heavy, unwieldy machine that it was originally.

The latest model consists of a single cylindrical drum mounted on the side of a Farmall tractor and made up of 16 rings, each having 30 picking fingers about 3 inches long radiating outward from it. The fingers are about ¼ inch at the point, tapering back to a round base of around ½ to ⅝ inch in diameter. They are provided with three



The Haring cotton picker

The Meyercord cotton picker



The American cotton harvester in operation

long and three short longitudinally extending grooves undercut at one side, and a series of teeth at the undercut side of each groove wholly within the circumference of the circle described by the body of the finger and pointing at an angle, to the length of the groove and inclined toward the free end of the finger. Each set of 30 fingers is driven at 2800 revolutions per minute by a ring gear mounted on a central drive shaft. The cotton is removed from the fingers, without reversing, by doffers.

The name, J. F. Appleby will be remembered as the man who won fame by inventing and perfecting a knotter for grain binders. He also attempted to perfect a cotton picking spindle upon which he was granted a patent June 14, 1904. Then on September 5, 1905, he was granted a patent on a cotton harvesting machine which had a drum of spindles mounted on a horizontal shaft in such a way that they would project downward through the cotton plants as the machine passed over them. Other patents were taken out from 1906 to 1913 as improvements on this first machine. Then on November 11, 1913, he was granted a patent on a cotton harvester which he describes as "a cotton picking machine including two picking mechanisms mounted on the same vehicle and adapted together to pass between adjacent rows of cotton plants". This apparently was the first patent granted upon a two-row cotton harvester since he mentions in his patent that it was well known by those skilled in the art that cotton picking machines have hitherto been devised employing two picking mechanisms with fingers attached to move in horizontal planes but the picking fingers in both picking mechanisms operate upon the cotton plants of a single row.

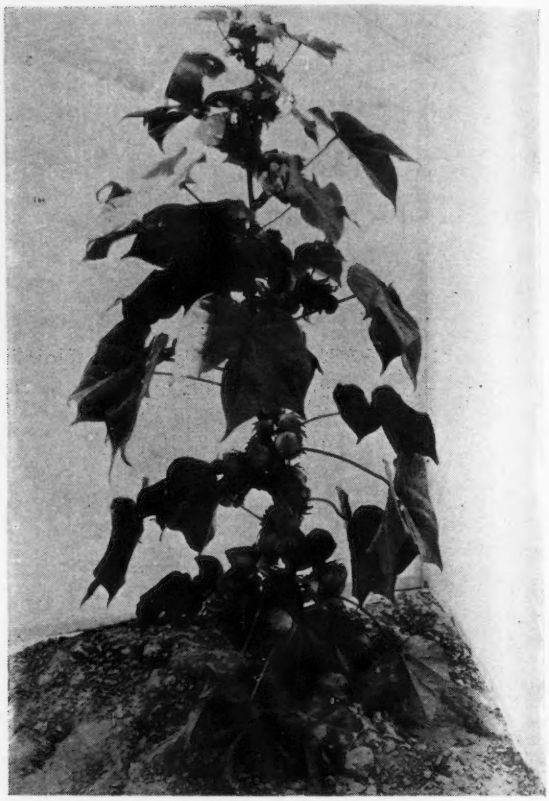
"In the device of my invention the picking fingers of a single picking mechanism pick the cotton from the plants of one row and the picking fingers of the companion picking mechanism pick the cotton from the plants of an adjacent row."

Other machines being developed at the present time are the Berry, the Meyercord, the American, and the Smith-Johnson.

The Berry cotton harvester, patented and developed by H. N. Berry of Greenville, Miss., makes use of two picking cylinders having fingers rotating in a horizontal plane and extending into the cotton plant from both sides. The spindle they use is similar to the type Campbell originally invented. They, however, have a unique way of removing the cotton from the picking finger, after reversing its direction of rotation, by pushing the cotton off with a sliding sleeve operated by an eccentric track.

B. Johnson, of Temple, Texas, was granted patents on a cotton picker February 17, 1917, June 19, 1917, and March 18, 1918. His machine used rotary spindles like many other machines, but the action while picking cotton is quite different. The action is described as having three motions in the picking process as follows:

1. The needle or spindle is projected into the cotton plant; the thrust motion engages the teeth in the fiber of the cotton



This cotton plant, isolated in 1930, is the result of the work up to date of the Texas Agricultural Experiment Station to develop a variety of cotton that would be well suited to mechanical harvesting. This plant shows desirable characteristics for that purpose

2. The rotary motion twists or picks the fiber out of the burr
3. The return motion of the needle or spindle, passing through a rotary sleeve, sheds and drops the cotton into a pan where a suction of air draws it into the receptacle on the rear of the machine.

This picker is now called the Smith-Johnson cotton picker. Improvements are being made with the idea of ultimately placing it on the market along with their "combine" cotton harvester.

Another machine that has attracted considerable attention from time to time is the Haring cotton harvester, invented and developed by P. P. Haring of Goliad, Texas. The original patent of his machine was granted July 27, 1897. Since that time he has made considerable improvement in his machine. The picking unit developed by Mr. Haring consists of two metal corkscrew-like prongs which revolve when in contact with the cotton so that they catch, twist and pull it from the bolls. In operation, when the picking arms upon which the fingers are mounted, taking the place of the ordinary spindle, have been withdrawn from the plant and revolved around to the rear side, the rotation of the curved fingers is reversed, thereby releasing the cotton.

Another machine using a type of picking unit similar to that used by Haring, is the Meyercord cotton harvester. This machine, however, has four vertically mounted drums which have 828 of these picking units per drum. The fingers are driven by frictional units inside the drum but their action is similar to that of the Haring machine, that is, the curved corkscrew-like fingers rotate catching the cotton while in contact with the plant and when reversed releases the cotton on the opposite side of the drum. There

are four drums suspended under a Whippet automobile chassis, two drums to the front and two on the rear. The rotation of these drums is synchronized so that the side of the drum in contact with the plant moves back at approximately the same rate of speed that the machine moves forward along the row. The plants pass between each set of drums, which are spaced about two inches apart, thereby giving two pickings each time the machine passes over the plants. In each set of drums one of them is traveling about 10 per cent faster than the other, so that bolls of cotton which are covered by leaves might be uncovered, allowing the picking fingers to come in contact with them.

A machine that has received a great deal of publicity is the American. The forerunner of this machine, however, was a small hand-operated affair developed and patented by L. C. Stukenborg, December 13, 1910. This hand machine was operated by two men, one holding the rear end, to which a bag was attached, and turning a crank which operated two endless belts fitted with brushes and turned so that when the forward end was directed to a cotton boll by a man holding that end the cotton would be brushed inwardly by the brushes on the belt and conveyed through the machine into the bag at the rear.

In 1915 a picking head was devised so that brushes revolving in this head would kick the cotton back upon a conveyor belt which would carry it to the container. Then in 1922 brushes were mounted in a picker head on the end of flexible hose so that, when the cotton was brushed out of the boll and kicked back into the hose, it would be drawn by a suction of air back into the bag. The latest development of this machine consists of substituting (for the brushes) wipers which kick the cotton back into the hose through which it is drawn and blown against a grate whereby it is partially cleaned. A small one-horsepower engine furnishes power for the operation of the fan and wipers. To operate this machine it is necessary that the picker head be held in one hand and directed to each individual boll which must be partially guided to the picker head. Therefore, the operator must use both hands and bend his back to pick cotton.

The suction or vacuum principle for harvesting cotton has been tried by many men without a great deal of success. The most promising machine of this type is the Thurman. It consists of two large vacuum tanks 22 inches in diameter by 10 feet long. Inside of each tank is attached a removable sack into which the cotton is drawn by vacuum through nozzles on the ends of six 75-foot hose. By simply placing the nozzles up close to the cotton boll the cotton is sucked into the sacks on the inside of the tank. When one sack is full the operator throws a vacuum lever, the vacuum sucks the cotton into the sack in the opposite tank while the full sack is being removed. It requires seven men to operate this outfit, six for the nozzles and one to operate the tractor who also acts as foreman of the crew.

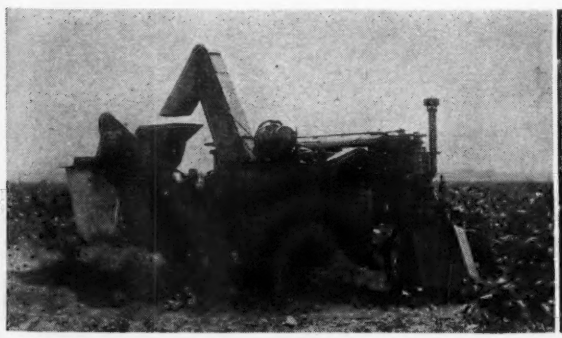
After considering all the various types of mechanical cotton harvesters it is found that it is difficult for any and all types to handle the crop. Even though progress is being made rapidly, we often wonder why it has been such a difficult task to develop a machine for harvesting the cotton crop. We may attribute the trouble to a number of factors which are not usually recognized, some of which are as follows:

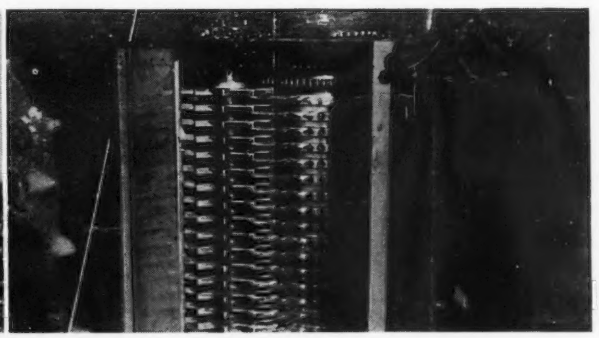
1. The cotton crop does not ripen and open within a very short period like most field crops.
2. The fiber hangs in the cotton burr rather closely making it difficult for any mechanical device using a projecting finger or suction to remove it from this burr.
3. Since the crop does not ripen uniformly the first and early opened cotton deteriorates very rapidly as the season advances. Consequently, losses will be incurred if the farmer waits until all of his crop is open before harvesting.
4. It is very difficult to remove the cotton from the burrs without also taking in with it parts of leaves and other foreign material.
5. The height of plant varies to such an extent that it is difficult to construct a machine that will adapt itself to plants only a few inches in height and to those 3 or 4 feet in height.
6. Many of the cotton bolls are either resting on the soil or are within a few inches of it. This makes it difficult for any mechanical device to get down low enough to get the cotton without also entangling weeds, grass and other vegetation near the ground.
7. There are so many different varieties of cotton grown in the various sections of the cotton belt each having different characteristics that it is difficult to build a machine adapted to harvest each of them.

As a general rule varieties of cotton commonly grown have numerous long vegetative branches making an excessive amount of leaves and foliage which often interferes with the ease of operation of the machine. It has been observed by many, however, who have been working on harvesting of cotton by machinery, that certain varieties appear to be better adapted to mechanical harvesting than others. Consequently, after looking over the various problems that must be overcome one can readily see that the nature of the cotton plant is largely responsible for retarding the development of a successful cotton harvester. With this in mind the Texas Agricultural Experiment Station outlined a project not only with the idea of developing a cotton harvester, but also to develop a variety of cotton that would be well suited to mechanical harvesting.

In 1927 a cotton plant having certain desirable characteristics from the standpoint of mechanical harvesting was found growing at Substation No. 8. This plant is being used as a basis for breeding work in the attempt to develop a more suitable variety for mechanical harvesting.

The plant was prolific, extremely early in maturing and





(Left) 1929 model I.H.C. single cylinder cotton picker. (Right) Picking fingers and doffers of the 1930 model of the same machine

produced its bolls in clusters on short stems close to the main branches, all of which are desirable characteristics so far as harvesting by machinery is concerned. In addition it had staple of good character, 1 1/16 to 1⅛ inches in length. It had, however, some undesirable characteristics such as long lateral branches, a low percentage of lint and small bolls lacking in storm resistance. To offset these undesirable characteristics, crosses were made on a number of other varieties having a high percentage of lint and large bolls which were relatively storm resistant, with the idea of imparting these desirable characteristics to the cluster-type strain. In this work we are striving to develop a type of plant without the usual lateral vegetative branches, but one which sets its bolls in numerous clusters on short fruiting branches borne on the main axis of the plant, and one which is characterized by large storm-proof bolls, extreme earliness with a comparatively short fruiting period, high percentage of lint, minimum of leaves and vegetative growth, and prolificness.

In 1928 the $F_1$ generation of these crosses were grown but since all plants had the same characteristics in this generation there was no opportunity for study and selection of desirable ones. In 1929 in the $F_2$ generation where segregation occurred several promising plant types were found. These were saved and planted the following year. In the $F_3$ generation which was grown in 1930 several plants were found which approached the ideal type. Those were isolated and will be studied further in 1931 to determine if they will breed true to type.

These plants had a very short maturity period; in fact, there was only 16 days from the time the first boll opened until the last boll was ready to pick. Most varieties of cotton have a maturity period of 35 to 50 days. Therefore, if this variety breeds true to type with an absence of vegetative branches and the stalk having very short axillary fruiting branches, a cluster type of fruiting with large stormproof bolls, it will no doubt give us a variety of cotton that can be grown with closer spacing in the row, give larger yields and be desirable for checking or hill planting and lend itself to mechanical harvesting because of the foregoing characteristics, and also because there is a minimum amount of foliage on the plant. Should this variety come up to our expectations we feel that it will simplify the problem of making a mechanical harvester that will harvest such a type of cotton. It will also make it possible to get in the fields with the mechanical harvester in the early part of September, harvest all the cotton at one time over and before it is damaged by bad weather conditions which usually begin sometime in October.

# Grading Students in Farm Mechanics

By C. T. Cheney[1]

ONE of the big problems of any teacher, and especially the teacher of a laboratory course such as farm mechanics, is that of fairly and accurately grading the students. The grading system should include not only a record of the work done, but if possible, it should be devised so as to induce each student to put forth his best efforts at all times. Furthermore, the students exerting the greatest effort should be rewarded, and likewise those who may be only drifting along should be detected and graded accordingly.

With the above requirements in mind we set about to devise a grading system which would satisfactorily meet them.

The projects in each phase of the course in farm mechanics were analyzed from the standpoint of skill and time required to do them, and a number of points were assigned to each. The maximum number of points which could be made for the quarter was set at 1000, the equivalent of 100 per cent. The minimum for a passing grade is 750. Each project was likewise assigned a maximum and minimum number of points. This course in farm mechanics is a two-credit laboratory course with two three-hour periods per week or a total of seventy-two hours per quarter. The 1000 points divided by seventy-two gives fourteen points for the value of each laboratory hour of the course. This hourly value was considered in assigning points to each project.

Every phase of the work is introduced by a class discussion and demonstration lasting about one hour. The students are given points for class discussions as well as for doing the actual projects. These points may be recorded at the end of the laboratory period while the discussion is fresh in the mind of the instructor, or they may be given to the student when the project relating to the discussion is graded. A project well done, concerning which the student is well informed, would tend to indicate that the student had paid attention to the discussion and demonstration.

An additional motivation scheme is a 14x18-inch progress chart posted on the bulletin board in the laboratory. It is made with a sheet of white paper glued to a sheet of heavier black paper. The white sheet is ruled horizontally for students' names and vertically for number of points. A strip of the white paper between each horizontal line is perforated and may be torn out disclosing the black background as a graph to represent the points made. The students record the points on the charts by tearing off a strip of white paper as their projects are graded.

This system is being used for grading four sections of farm mechanics students, with a total enrollment of eighty-three. The points for every student in the four sections are recorded daily in a four by six-inch notebook which opens at the side. The left-hand side of one page holds the names of all the members of one section. Then the next six or eight pages are clipped off so that the students' names will not be covered by the succeeding pages. The projects are written in at the top in vertical columns along with the points assigned. In this same notebook is also recorded the absences and the work to be taken up at each laboratory period.

Some of the advantages of this system of grading are:

1. Added incentive for more and better laboratory work because points are given according to quantity and quality of work done
2. Added incentive due to the graphical display of the points earned by each student, giving a comparison between his work and that of others in the class
3. Detection of the loafer, bluffer or poor student early in the course
4. Ease with which the mid-term or final grade may be made out. The total points made during the quarter divided by ten gives the final grade or provides for the ranking of the students for grading by any other system.

[1]Instructor in farm mechanics, Iowa State College.

## Reduced Labor Costs Important

THERE is need of larger farms in New York State, according to Prof. G. G. Warren, farm economist at the New York College of Agriculture. This is necessitated by the increased cost of labor as compared with before the war. By increasing the size of family farms Professor Warren states that machinery and equipment can be used more efficiently and labor costs lowered. This will increase the output per man, but not total production.

# Ultra-Violet Light in Poultry Production

By L. C. Prickett[1]

ULTRA-VIOLET lamps for treating poultry should never be purchased unless careful investigation shows that they will pay their way. Only by previously analyzing his own conditions can the poultryman assure himself against possible disappointment due to a misunderstanding of the opportunities such equipment offers. Thus we might summarize the results of investigations with such lamps, both of the carbon-arc and mercury-vapor types, carried on at various agricultural experiment stations throughout the country. Should the newer Mazda lamps prove as effective as some engineers expect, the field where ultra-violet light will definitely pay its way will be expanded enormously.

Nevertheless in certain specialized branches of the industry the chances for justifying the use of ultra-violet lamps are usually much greater than is ordinarily the case with commercial layers.

As is now well known, ultra-violet light is just as effective as the vitamin D content of cod liver oil in bringing about normal utilization of the calcium and phosphorus in the ration. In fact, it is quite likely that vitamin D is directly or indirectly a product produced by irradiation with sunlight, either natural or artificial.

Rickets in chicks and weak egg shells, also low hatchability of eggs from mature stock, are caused by rations with an inadequate supply of minerals or else by the inability to use the minerals (calcium and phosphorus) supplied.

Rations have a lot to do with the need for ultra-violet light. In fact, with feeds having a properly balanced mineral content, that is, three times as much calcium as phosphorus—the same proportions as are found in the bones—normal, healthy chicks can be successfully raised to the age of eight weeks without any ultra-violet light or vitamin D whatsoever. (Professor J. S. Hughes, professor of animal nutrition, department of chemistry, Kansas State Agricultural College, is authority for that statement.) With a rachitic ration (a mineral balance of, say, six times as much calcium as phosphorus) the chicks will be rickety at the end of two or three weeks. Furthermore, the influence of rations is just as observable with older stock, although the effects are different, as just mentioned.

The effective wave lengths of ultra-violet light lie between 2800 and 3200 Angstrom units (an Angstrom unit being equal to 0.0000001 millimeter, or about 0.000000004 inch), the most effective being around 3100 units—between the so-called "far" and "near" ultra-violet light, respectively. Visible sunlight ranges, very roughly, between about 7000 and 4000 Angstrom units, all the shorter invisible wave lengths being called ultra-violet light, nothing shorter than 2900 Angstrom units reaching the earth.

There are several companies manufacturing good quality ultra-violet lamps of both the carbon-arc and quartz-mercury types. The former type is more expensive to operate than the latter, due to carbon renewals, and unless special arrangements were made there might be some fire hazard. However, no fires of such origin have been reported to the best of my knowledge. The quartz-mercury lamps have comparatively fragile burners which are fairly expensive to replace. Normally they should operate at least one year and perhaps much longer.

Mercury tube or "factory lamps" which furnish considerable quantities of ultra-violet light have recently been placed on the market at lower prices. Quite recently, Mazda lamps operating at higher temperatures have been produced. The special glass bulbs are also transparent to ultra-violet light with the result that apparently worth while quantities of ultra-violet light are produced. Test data are not available but, if successful, we will be able to take care of the ultra-violet needs in the poultry house by merely relamping with the improved bulbs, that is, by combined poultry treating and poultry house lighting.

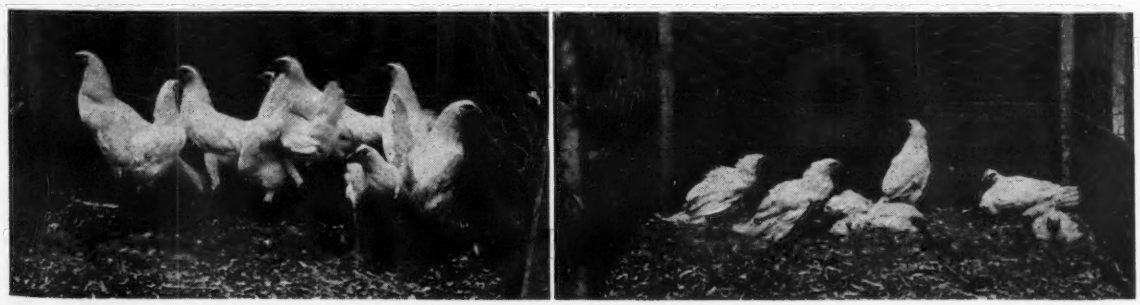
According to J. S. Hughes, quoted in a foregoing paragraph, the following treatments were effective in maintaining health with rachitic rations (much less would be required with rations containing a proper mineral balance.):

1. Three hours with a Cooper-Hewitt factory lamp (a recent model accomplishes this in one-half hour)
2. Quartz-mercury poultry treater at a distance of 30 inches for 10 minutes
3. A few minutes in direct sunlight (winter sunlight only one-eighth as effective as summer sunlight)
4. Feeding cod liver oil at the rate of 0.5 per cent in the ration, or a daily ration of 5 cc of milk which has been irradiated for thirty minutes (This irradiation destroys the vitamin A content.)

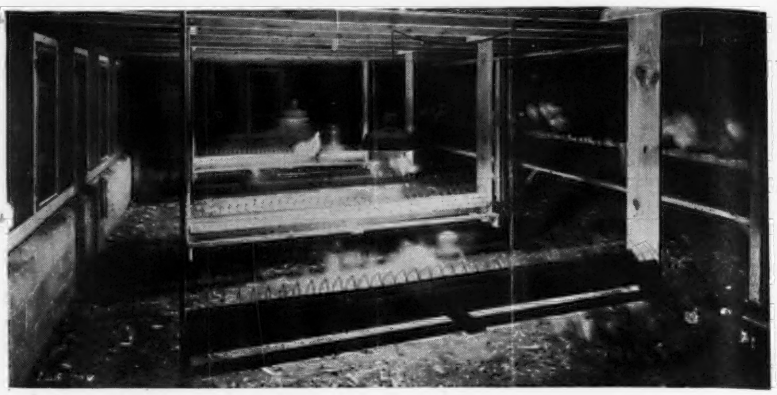
Investigation has shown that exposing the chickens' legs to the ultra-violet rays was the most effective method of treating; the next best, although scarcely a close second, was to expose their heads, the effectiveness varying with the comb development. A good covering of feathers seemed to prevent the light from reaching the body at the points covered. It would, therefore, seem advisable to mount lamps rather low; at least with battery brooders this would be feasible.

According to such authorities as J. E. Dougherty, professor of poultry husbandry, University of California, it

[1]Assistant director, Committee on the Relation of Electricity to Agriculture. Assoc. Mem. ASAE.



(Left) Well-developed young birds supplied with plenty of ultra-violet light. (Right) Remnants of a pen, originally the same as the one shown at the left, the only difference being that this group received no ultra-violet light, all the light coming through window-glass



Special Mazda lamps (CX-500-watt) furnishing both illumination and ultra-violet light. Tests are being made at various agricultural experiment stations of the adequacy of this source of ultra-violet light

would in many cases hardly seem profitable for the average poultryman to buy present day ultra-violet lamps, as counting first cost of high-grade equipment, operating expense, and labor of using, it is better to make arrangements for the very small amount of exposure to sunlight that is required in most sections, and to furnish cod liver oil during cloudy winter weather as required. Cod liver oil would be cheap and effective for such emergencies. In northern Wisconsin, Minnesota and similar areas, lamps are more apt to be profitable.

However, the wheeling out of tiers or sections of chickens in battery brooders (they will, of course, get along in good shape without any treatment up to eight weeks of age if fed properly) may be expensive enough from the standpoint of labor to justify the use of lamps.

Most present day lamps need watching and unless there are plenty of lamps they will have to be moved from pen to pen—not such a simple or easy task. Some poultrymen just hang the lamps over the mash hopper and are apparently satisfied with results.

Present day ultra-violet lights may well pay their way in the production of quality eggs. When cod liver oil is fed to hens, the eggs have a flavor which some discriminating people can detect, and as yet such substitutes as treated yeast are expensive or unobtainable. Furthermore, some producers of fancy eggs, especially those near the larger cities, have found the advertising value of irradiated hens justified the investment in lamps many times over. The consumer is thereby assured of high vitamin eggs regardless of the weather, negligence of hired help, or what not.

As mentioned previously the new Mazda lamps recently placed on the market may make it economical and practical to use combination lighting in chicken houses. Test data are not yet available.

When the use of glass substitutes is considered for skylights, chicken house fronts, etc., their relative transparency to ultra-violet light should be considered. This transparency is greatly reduced by dust or dirt, especially with such material as wire screen covered with compound, being very difficult or impossible to remove. Many glasses when they solarize or become stable have only 50 per cent or less of their original transparency to ultra-violet. The use of glass substitutes can scarcely be expected to produce results that would justify a very high investment in such equipment.

# The Use of Dynamite in the Maintenance of Open Ditches

AN OPEN ditch should be as good 20 years after construction as when new, if it has received a little attention each year, but very few counties in Ohio have a definite and adequate program of ditch maintenance. Northwestern Ohio has as many as five thousand miles of open ditch per county, costing from $5,000,000 to $10,000,000. In many cases, these ditches are constructed and then forgotten until the growth of vegetation and the deposition of sediment has rendered them almost useless. When finally cleaned, the cost is almost as great as for the original construction.

A survey of other states indicates that none of them has a definite program of open-ditch maintenance, but they all recognize the need of such a program.

In May and June of 1930 a series of experiments was conducted in Wood County (Ohio) to determine the efficacy of dynamite in open-ditch maintenance. The experiments covered a wide range, both with respect to neglect and to size of ditch. Two methods of loading were used. In one, the charges, usually single sticks, were placed close together; in the other, more concentrated charges were spaced farther apart. The concentrated load gave the highest efficiency. The following is a summary of conclusions from these experiments:

Dynamite is a quick and easy means of removing obstructions from the channel.

It can often be used economically on jobs too small to warrant the use of dredging equipment.

It scatters the material, thus avoiding high spoil banks.

Small jobs can be done as cheaply per unit of material removed as large ones.

It is a convenient method of removing obstructions as soon as they appear.

Dynamite cannot be safely used where the ditch passes near buildings or other structures.

Crops growing near the ditch may be damaged by material thrown by the blast.

Best results can be obtained only when the soil is completely saturated, but there should not be a great amount of water in the ditch at the time of blasting. It takes about as much dynamite to remove surplus water as to remove an equal amount of soil.

It is necessary to use dynamite sensitive enough to be fired by "propagation;" that is, the explosion of one charge will set off the one next to it and so on.

Under favorable conditions it will require 0.63 pounds, or a little more than one stick of dynamite, to remove one cubic yard of soil.

With unfavorable conditions or improper placing of the charges it may require as much as two pounds of dynamite per cubic yard of material removed.

## TILE DRAIN

Other drainage projects consist of a determination of the effect of joint space on the efficiency of tile drains. This work consists of making laboratory and field tests. No results are ready for reporting at this time.

Measurements are being made of the discharge from tile drainage systems. Recording instruments are used to determine the flow from systematic drainage systems throughout the state. This work will require a period of at least five years and will make it possible to determine more accurately the proper size of tile mains for Ohio conditions.

From a report by Virgil Overholt, agricultural engineer, to the Ohio Agricultural Experiment Station.

# Developing the Right Attitude Toward Farm Building Design[1]

By H. C. Wichers[2]

TO ME the farmhouse problem is one of the most interesting architectural problems of the present time. It presents individual problems and characteristics like no other particular building, and yet the difference is not great enough to catch the attention of other than the interested or informed individual.

We have given too little thought to the farmhouse. There has been too much putting on of porches and extraneous surface patches, and not enough careful thinking in regard to the problem proper. The result is that there is comparatively little material available that deals especially with the farmhouse problem. I did not realize just how little was available until about three or four years ago when I first gave thought to a bulletin which presented material for the farmhouse and the farmhouse alone. The further I looked, the less I found, and outside of some material on farmhouses published by the federal department of agriculture, a few houses that appeared from time to time in farm magazines, some discussions in books, including those of W. D. Brinckloe, Greta Gray, some plans developed by W. G. Ward, and one or two other bulletins published by state agricultural colleges, there is practically no material that is of real value to the farmer. When you compare the vast array of material available on city houses and the number of companies who make it their business to supply plans at very small cost, one can readily see why the farm house has lagged, and why the city house plan has been forced into the awkward position of pinch-hitting on the farm.

The more important problems in farmhouse design, as in any other worthwhile problem, have to do with things of much more importance than the manipulations of the material elements — the brick, stone, tile, lumber, and shingles. To be sure, these things form the elements with which the finished structure is built, and in the finished farmhouse the correct use of these will be the proof of the designer's ability — in the same way that the written word is the proof of the writer's conception. But the real problem is not one of sticks and stones, nor pen and ink, but of thinking. Once the thinking is correctly done we have no doubt as to the outcome. The outcome may not measure up to the thought-out conclusion the first time we try to express it in materials, but we are certain that after the thinking is done it is only a matter of time, a matter of testing, building, trying, and doggedly holding to our conception.

Most of us as engineers are a good deal more concerned in our everyday living with the process of developing conceptions so that others may have them. Once we are convinced that a certain idea can be developed, materialized, or externallized, we, as engineers, make it our business to force these ideas out and a great many more of us are busy with the forcing process than with the primary conception.

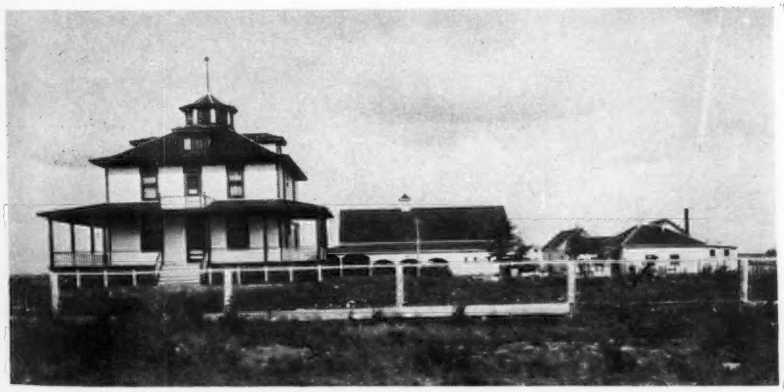
There are always those who can conceive of better conditions than the average man is willing to admit. It is always possible to provide better designs than will be generally accepted. And even though these conceptions are excellent in themselves and may actually solve the problem as it should be solved, until we can get the average man to conceive of them, to think in terms of them, we have only started, and sometimes this process of placing a new conception in an understandable form is one of the hardest parts in a new development. The average man must see himself in and living with these new things before they will become a part of everyday living. So then the chief farmhouse problem is that of education, and this the state agricultural colleges and extension service, the federal department of agriculture, architects, and writers are attempting as fast as methods and ideas present themselves.

## THE NECESSITY OF CHANGE

It is very human to do things in the manner in which we have been taught. Yet we know that in this material universe change is the only constant element. It is interesting to watch the development of various industries, farming being no exception, and note the perpetual change that is taking place on all sides. The manufacturing process that may be considered the very pinnacle of development in any particular manufacturing concern today may next year, or the year after, be entirely scrapped and written off the books as so much junk. But the manufacturer does not consider such development as loss. He considers it very expensive, but not loss. In fact, many of them employ men to find fault with their manufacturing processes. To be sure many of the new developments, or rather suggestions, are not accepted, but many of these suggestions are tried at great expense, and when found to be good steps are immediately taken to replace the old with the new.

[1]Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers at Chicago, December, 1930.

[2]Assistant professor of rural architecture, Kansas State Agricultural College.



The author of this paper advances the opinion that agricultural engineers and others concerned with farm building problems should adopt the methods of the successful advertiser in presenting new ideas on farm building design and improvement. He also calls attention to the great need of creating the desire for higher ideals, higher standards in farm buildings especially in the case of the farm home

But first we must conceive of the new. Next we must be convinced that the new is worthwhile and possible. After that there is nothing left but the physical developmental process. The first two are vital and fundamental; I consider them even more important than the actual developing process. And when a new project has passed this second stage, it is two-thirds accomplished. Not that the developmental is not necessary; on the contrary, it is all important as far as presenting ideas for public use is concerned. Inventions and new ideas may lie dormant for years after discovery because of lack of means to develop the ideas for public use. But, nevertheless, a crystallized conception means that it has been born. It will grow in due time. So then the magazines are doing a wonderful work when they present month after month, week after week, year after year, ideas that will give the farmer a new conception of what a farmhouse should be. Infrequent attempts are good in themselves but do not bring the returns that consistent, everlasting hammering will.

## ADVERTISING METHODS

We must use the methods of the successful advertiser in presenting new ideas for public consumption. Some of us as staff members of agricultural colleges have much information that is of real value. We have many crystallized conceptions, many ideas, but until they are presented, until they are made known and placed in an attractive (desire provoking) package they will not be quickly or generally devoured. The advertiser considers the proper presentation of subject matter as tremendously important, as will be witnessed by the enormous sums spent by large manufacturing concerns to obtain well-presented advertising matter. We must use the same methods, although they need not be so blatant nor yet so false as some of the billboard advertising seems to be.

By far the largest majority of people can not take time to study carefully the farm home problem. It is up to a comparatively few people to study it for them and present it in such form that the layman will buy it at a low price and still be able to know that what he buys is good. This I am sure is not a wild dream. We have a remarkable example of what can be done in many manufactured articles. Just what the process is, how it will be developed, and how presented we are not at all sure as yet. But people are conceiving of these things. When the conception has crystallized, the results will be almost immediate. So much for the vision.

Another of the problems that presents itself to the farmhouse builder is that of realizing clearly and definitely that the farm home is a living, pulsing, growing thing. The attitude of all home builders is so likely to be that of rushing a project to completion that, they are convinced, will be finished when the painter leaves the house. Yet any of us can give ample proof that a home is never finished. Further, we know that the happiest folk are those who behave or act as though it were never finished. A thing finished is a thing dead. Let's convince the farmhome builder of this fact. It will have a remarkable effect on the appearance and condition of farm homes, once they are convinced of this.

## LOW STANDARDS FOR FARM HOUSES

A peculiar point of view that I find to be rather common in the farm home builder is one which, at the present time, seems a bit more common than in other people. It is one that I have been at a loss to cope with in any other way than that of slow education through bulletin material and magazines. It is a seemingly hopeless task to make building time converts. In order to present this viewpoint I will have to relate a story. Not long ago I acted in a professional capacity; it was not full service but a partial service job for a young man just starting a farming career. He was a graduate of an agricultural college and as such rated rather well. He came of a good family. Family pride was strong. The entire family thought much of the homestead. In fact, they were inclined to think more of it than the average long-time owner. The boy had lived in a university town for four years and was thoroughly acquainted with all modern conveniences as they are found in such a town. During his stay in the city he became a member of and lived in one of the better fraternities. He moved in a circle of friends that would mark him as one having high ideals and ambitions.

Shortly after graduation he became joint heir of the home farm and in order to live there he had to build himself a house. With a background of this type, with sufficient money to build well, a natural pride in the homestead, and a love for farming one would think that this boy would build a good farm home, and in his own mind he was convinced that that was what he intended to do. I had not worked with the man for more than two hours before I realized that his conception of a good farmhome was so far below his conception of a good city home that the two ideas did not belong in the same class. Here are a few of the elements of his double conception:

In the city house he expected water pressure of somewhere around forty to sixty pounds per square inch; in his new farm house he was satisfied with practically no water pressure. He was satisfied with a fall of four feet at a distance of one hundred yards. His water supply was a spring. In a city house he expected the windows and screens to be excellent in workmanship and materials; in his own farm home he was satisfied with makeshifts that he himself could build. In the city house he expected concrete steps and floors to be excellent as to materials and workmanship; in the farmhouse he was satisfied with poor labor, most of which was done himself or by help which he used on the farm, not skilled building labor. In the city house he insisted on the best plumbers and plumbing fixtures; in his own home he hired second-rate plumbers and was satisfied with many makeshifts. This attitude is not unusual. I have encountered similar attitudes in a large number of families, and it forms one of the chief problems to be met in farm home design. The reason I am convinced that this young man could conceive of good homes in the city was the fact that he was an active member of the building committee for his fraternity when they were building a new house, and the remarkable change in attitude was indeed difficult to fathom.

## RAISING FARM HOME STANDARDS

The only method of completely changing such an erroneous conception, such an injurious idea, is by deliberately taking and holding and advertising the opposite attitude. Think, talk, and write more ideal conditions for farmhomes. Good farm homes are good for everyone. Therefore, there is no harmful influence that can come from propaganda of that type. It raises the living standard, advances the cultural standard, increases the prosperity of everyone involved.

One of the methods that can be used is that of a continual bombardment of prospective farm home builders with a continuous stream of photographs, short articles, bulletins, etc., which present the right kind of information in a form that will be read and if possible studied. This includes information on kitchens, offices, baths, running water, garages, yards, floors, walls, and most important of all at the present time, really good, workable farmhome plans. This is only one method of attack. The extension service presents a method that is almost ideal because of personal contact. But these people too must make use of photographs and pictures, because they are better understood by the average man. But new ideas and new conceptions must be dreamed before they are built.

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(EDITOR'S NOTE: This paper was followed by a slide lecture, the slides being made from illustrations used in Bulletin No. 23 of the Engineering Experiment Station, Kansas State Agricultural College.)

# Opportunities for Agricultural Engineering Research in the Southeastern States[1]

By R. W. Trullinger[2]

President, American Society of Agricultural Engineers

THE southeastern states of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, and Kentucky as a group produce practically every crop grown in the southern United States, including cotton, corn, potatoes, hay, tobacco, rice and other small grains, sugarcane, truck crops, and small and large fruits, especially citrus. Dairying and animal and poultry production is also quite general throughout the region. While they are usually incidental to crop production, in some sections they are fairly stable and basic industries and possibly will become more so under the impetus of the southern livestock program being formulated by the U. S. Department of Agriculture.

Some fairly large farms are found particularly in the major cotton-growing sections, but the region as a whole appears to be essentially the home of the medium and small-sized farm. Also in areas such as the cotton and citrus belts the agriculture frequently is devoted to one specialty in large, medium, and small-sized units, although the tendency for diversification is growing.

For practical purposes the programs of research in progress at the agricultural experiment stations in the states concerned may be considered to indicate the important problems confronting the agriculture of the region. During the fiscal year ended June 30, 1930, they totaled somewhat over a thousand projects. However, less than 2 per cent of these projects could be classed as agricultural engineering, and they represented an expenditure of only about 1 per cent of the total amount expended for agricultural research in the region during the year. For the United States as a whole, on the other hand, the percentage of agricultural engineering research at the experiment stations approximated 4.5 per cent in number of projects, and 4 per cent in expenditure of funds. This included several arid or semiarid states and industrial states which are not primarily agricultural. The Southeast being primarily an agricultural section therefore appears to be far below the average in the development of agricultural engineering in the solution of agricultural problems.

A first-hand observation during the past year of the programs of research at the agricultural experiment stations in the southeastern states has revealed numerous instances in which it would appear that engineering could participate to advantage. Attention is therefore drawn to the general nature of a few outstanding instances of this character.

The production of field, truck, and fruit crops is preponderantly the most important feature of the agriculture of the Southeast. This is suggested by the fact that practically 80 per cent of the research at the agricultural experiment stations of the region is centered on problems of crop production, including soil preparation, cultivation, fertilization, planting, growing, harvesting, breeding, storage, and marketing of crops, and combating crop diseases and insect pests. The predominance of small and medium-scale farming in the region suggests also that much of the field and forage crop production, with the exception of cotton, is primarily for the home support of small livestock enterprises.

Of the field crops grown in the region, cotton is the most widespread and generally important money crop, and is more or less typical of the field crops in its general cultural requirements. An examination of the research programs relating to cotton reveals problems of tillage, planting, fertilization, cultivation, dusting for insect control, harvesting, ginning, seed processing, and storage, in which it would appear that the engineer may be of valuable assistance.

Seedbed preparation, including plowing, harrowing, and the like consumes a relatively large proportion of the total power required in the production of a cotton crop, and is therefore an expensive feature. It seems important, therefore, that the agricultural engineers study the cotton soils of the region in cooperation with the soils technologists and the agronomists with the idea of developing tillage methods and tools which will adequately produce the degrees of tilth required for the best germination and growth of cotton in the different soils with a minimum cost for labor and power.

The so-called soil dynamics research at the Alabama

[1]Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers, at Atlanta, Ga., February 5, 1931.

[2]Senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

Because of the importance of seedbed preparation in the production of cotton, agricultural engineers in the southeastern states are urged by Mr. Trullinger in the accompanying paper to study the cotton soils of that region in cooperation with the soils technologists and the agronomists with the idea of developing tillage methods and tools which will adequately produce the degrees of tilth required for the best germination and growth of cotton in the different soils with a minimum power and labor cost

Agricultural Experiment Station, which is elucidating the fundamental principles of tillage in different soils to provide a rational basis for tillage implement design, is a striking example of this kind of agricultural engineering investigation. Its practical end point is reflected in the ability of that station to state with confidence, for example, that the cylinder disk plow is satisfactory for the tillage of sandy or loam soil, but is not well adapted to Black Belt soils. Thus a knowledge of the fundamental principles of soil dynamics and the mechanics of tillage is essential, not only to the proper development of tillage methods and equipment to meet the tillage requirements of cotton and other crops, but to the intelligent judgment of the merits of available tillage methods and machines with reference to their economical and efficient adaptation to different types of farming and sizes of farming units.

## COTTON PRODUCTION PROBLEMS

The planting of cotton so as to insure a satisfactory stand offers a peculiarly important and difficult problem for engineering solution in many parts of the Southeast. In some sections the soil and climatic conditions in the spring are such that cottonseed must germinate under a hard soil crust, and the young plant must force its way upward through the crust. The situation is especially difficult under conditions of wilt or other diseases and the securing of a stand becomes an uncertainty.

Studies of the causes of formation of crusts in certain of these soils after rainfall have been started at the Alabama and Mississippi Agricultural Experiment Stations, for example, with the idea of developing methods of treatment and tillage to prevent their formation so far as possible. Assuming the inevitable formation of crusts under certain conditions, other studies are being made of the breaking strength of typical soil crusts and of the vertical pressure which the individual growing cotton plant is able to exert against them. These studies are aimed at the development of proper planting methods with reference to number of seeds required per hill or per unit area of soil surface, depth of planting, and the like. With this basic information the necessary planting methods and machinery are being gradually developed with some assurance that they will render satisfactory results. In the Middle South, the Arkansas station has reported considerable progress in the development of hill planting of cotton under similar conditions.

Fertilization is offering an important problem needing engineering attention, especially since the advent of some of the new concentrated fertilizers. A national committee, consisting of several experiment stations, the National Fertilizer Association, the American Society of Agricultural Engineers, the U. S. Department of Agriculture, and other agencies, has been working on this problem for several years. Owing to the cost of fertilizers and the expense of placement in power and labor, it is important that fertilization practices be so developed as to secure maximum utility and minimum injury of the fertilizer to the crop at minimum expenditures of power and labor for placement.

Obviously this calls for cooperation with the agronomist and soils specialist to establish the rates of application and time and manner of placement of fertilizers required by the cotton crop in different soils. The engineering problem is to develop fertilization methods and machinery which will meet these basic requirements using different types of fertilizer. The problem seems so important throughout the cotton-growing regions as to command rather widespread engineering attention, and progress already has been reported by some stations.

Cotton cultivation, like seedbed preparation, consumes considerable power and is one of the expensive items of cotton production. The Mississippi and Alabama stations of the Southeast and the Arkansas station of the Middle South already are showing how, by proper planting and row spacing and by the use of proper machinery, the cost of cultivation of cotton can be appreciably reduced. The Arkansas station especially has developed hill planting, cross harrowing, and checkered cultivation to a point where hoeing and hand-thinning are practically eliminated. The Alabama station also has demonstrated the utility of the pipe gang, large wheel, pivot-axle cultivator for work on bedded or furrow crops in certain localities. In every instance, however, cooperation with the agronomist and soils specialist seems advisable to establish the cultivation requirements of the crop in different soils as a basis for the development of adequate cultivation methods and machinery.

The control of the insect pests of cotton, such as the boll weevil, pink bollworm, cotton hopper, red spider, and others, is a problem confronting entomologists throughout the Southeast. From the economic standpoint, the use of dusts for control seems imperative. The entomological studies are indicating the time and manner of dusting which is most destructive to the different insects. This offers an interesting and worth while opportunity for engineers to cooperate by undertaking the development of methods and machinery which will properly project and deposit the dusts where they will do the most good. A study of the physics of dust movement in air under pressure would seem to be an important preliminary to such work.

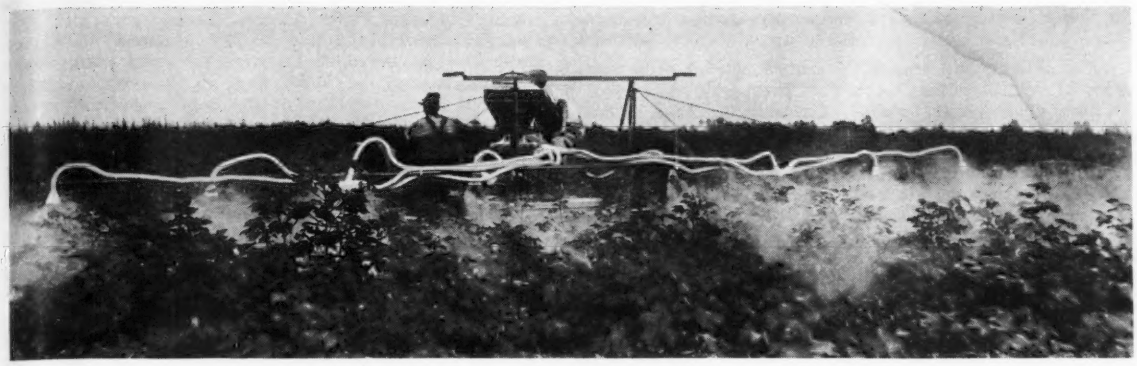
The harvesting of cotton so far is largely a hand operation and is one of the big expense items in cotton production owing to the excessive amount of labor required. It is of paramount importance to lower the cost of production in every possible respect so long as the quality of the product is not impaired. Several beginnings have been made in the development of mechanical cotton harvesters, notably by the Texas station, and progress gradually is being made in their further improvement. The whole matter of cotton harvesting therefore offers the agricultural engineers in the southeastern states a most interesting and worth while opportunity for constructive research along definite cost-saving lines in cooperation with the cotton specialists.

The ginning of cotton appears to have never been placed upon a fully satisfactory basis. The Mississippi station recently entered into an investigation of cotton-ginning methods and machinery with the idea of introducing greater efficiency and economy into the process. This has called for laboratory studies of the different mechanical features of the ginning process under controlled conditions of temperature and humidity to learn the requirements for producing properly ginned cotton as bases for the further development and improvement of the process and equipment. Such work obviously calls for cooperation with cotton specialists and offers numerous worth while opportunities for engineering participation.

## CORN IN THE SOUTHEAST

Corn probably follows cotton closely as a generally important field crop in the Southeast, being utilized largely for home consumption by livestock. Its economical production offers the agricultural engineer problems of tillage, planting, fertilization, cultivation, harvesting, storage, and processing for stock feed similar to those offered by cotton. Cooperation with the soils technologist and agronomist in establishing the seedbed, planting, fertilization, and cultivation requirements of corn in different soils and the development of methods and tools which will meet these requirements satisfactorily with a minimum cost for power and labor constitute proper activities for agricultural engineers. Cooperation with livestock and dairy husbandry specialists in developing the mechanical processing of corn into silage and ground feed offers the engineers other opportunities for research. These problems certainly need more thorough solution in the southeastern states, with special reference to the requirements of the medium and smaller-sized farms.

The harvesting of corn is a time and labor-consuming hand operation, and considerable progress has been made



The pathological and entomological studies which are aimed at the control of plant diseases and insects injurious to crops offer an especially wide field for profitable engineering investigations, leading to the development and application of suitable mechanical equipment

in the corn belt and elsewhere in the development of mechanical methods of corn picking. The problem offered in the Southeast is perhaps not so much one of new methods and machines as it is one of adaptation or redevelopment of those available to economically meet the requirements of the medium and small-sized farms for corn harvesting.

Other field crops such as potatoes, cane, tobacco, rice, and the like offer similar problems of planting, tillage, fertilization, insect control, harvesting, and storage. Cane cultivation, for example, especially under lowland conditions where ditching between rows is necessary to carry off seepage water, presents a challenge to the ingenuity of the agricultural engineer. In several localities of the Southeast and in Louisiana in the Middle South, none of the tillage tools available has been found economically adaptable to the cultivation of cane under such conditions. The necessity for considerable development and specific improvement for this purpose is evident.

In parts of the Southeast the loss of hay crops through inclement weather is frequent and serious. Under such circumstances natural methods of hay harvesting and curing become of uncertain utility. Furthermore, where considerable dairy and other livestock are fed such forage, it is of great economic importance that the forage be of uniformly high quality.

The artificial curing of hay crops, therefore, is being recognized as a necessity to the production of quality forage in humid regions where dairy and other livestock are fed. The Louisiana station in the Middle South, for example, has developed the process and necessary equipment to a considerable degree. The Mississippi and Alabama stations have undertaken similar studies of an even more fundamental nature. These call for cooperation with the plant physiologist and agronomist to elucidate the fundamental mechanism of moisture removal from and curing of hays of different types, and to determine how this mechanism may be controlled by artificial means. They also call for cooperation with the animal nutrition specialist to establish the requirements for and insure quality in the cured product. Thus an opportunity is offered the agricultural engineers throughout the Southeast to aid in the production of high-grade forage for dairy and other stock.

Practically every agricultural experiment station in the Southeast is conducting an extensive program of research in pomology, plant physiology, plant pathology, and entomology, aimed at the economical production of high-grade fruit crops. Studies of orchard management and of the place of a fruit orchard in a diversified system of medium or small-scale farming are numerous, primary consideration being given to the power and labor items involved in planting, pruning, fertilization, spraying, picking, storage, packing, and transportation. In the citrus belt also the problem of adequate frost protection is ever present and offers an opportunity of unusual economic importance for engineering attention.

The pathological and entomological studies which are aimed at the control of fruit diseases and insects injurious to fruit trees and crops offer an especially wide field for profitable engineering investigations. The tendency among entomologists, for example, now is to elucidate the fundamental relation between the physical properties of the surfaces of the vital organs of insects and those of the surfaces of certain insecticides. The idea is to develop the physical properties of the insecticides so that when properly applied they will stick and spread on the vital surfaces of insects and produce a maximum kill. Also, pathologists and especially entomologists are finding that many important pests can be attacked and killed most easily and economically at certain times and places.

The proper projection and deposition of dusts and sprays call for the development of methods and mechanical equipment which will specifically meet the requirements for the destruction of individual insects and diseases. Thus studies are necessary of the physics of these materials under pressure and the development of the mechanical principles of the apparatus required for projecting and depositing them where they will do the most good. Such research calls for the coordination of the highest type of engineering skill with that of horticulturists, entomologists, pathologists, and chemists in the identification and proper manipulation of the important physical and mechanical principles involved.

Practically every state in the Southeast produces truck crops, especially tomatoes, sweet corn, beans, peas, sweet potatoes and other root crops, and melons and cucumbers. Truck growing ranges from rather specialized operations on a large scale to average or small-scale gardening as a feature of diversified farming.

The problems of seedbed preparation, fertilization, planting, cultivation, spraying and dusting for insect and disease control, and harvesting are in general similar to those of field crop production, especially potatoes. They offer the same excellent opportunities for profitable engineering participation, and suggest the additional possibility, for example, of developing and adapting small-unit, general-purpose, labor-saving machinery for tillage, fertilization, planting, and cultivation, especially for medium-sized trucking operations.

The diseases and insect pests of truck crops are numerous and varied, and many types and kinds of treatment used in their control involve special engineering features of spraying, dusting, heat application and the like. The bean jassid in Florida, the belted bean beetle in Alabama, the bean leaf beetle and Mexican bean beetle in South Carolina, the cucumber pickle worm in Tennessee, the harlequin bug in North Carolina, and other economically important insect pests are being studied by the entomolo-

gists of the region, and are being found in many cases to require some kind of mechanically applied treatment. The engineering problems offered are almost self-evident.

The storage problems in the fruit and truck crop industries are quite general throughout the region, and appear to have many phases which yet remain unsolved. Physiological chemists and pathologists seem to have established that apples, peaches, and other fruits usually can not be stored with other crops without some loss. It is also known that certain rather definite temperatures and conditions of humidity are desirable for different varieties of fruits and truck crops, and that certain storage conditions are favorable and others are unfavorable to some of the important storage diseases of different fruits and vegetables. The North Carolina station, for example, has been especially interested in the feature with reference to the storage of sweet potatoes. There is also considerable evidence available in some quarters which points to the fact that some types of storage lower the nutritive quality of certain fruits and vegetables, while other types of storage cause them to deteriorate generally in quality. The sweet potato, for example, is one of the important truck crops in the Southeast which offers a difficult problem of curing and storage, while peaches, apples, pears, citrus fruits, and small fruits all introduce storage difficulties in which agricultural engineers should be interested.

An interesting and important feature is involved in the development of cold storages to prolong the salable life of some perishable fruits and vegetables and in defining the limitations for their profitable adaptation. The development of processes for economically freezing fruits, such as strawberries, peaches, figs, and the like, at extremely low temperatures to produce a more salable product also offers an extremely interesting engineering problem. Such work happens to be in progress at the Georgia station.

The considerable amount of research of this general character in progress at the experiment stations in the region is establishing the bases upon which agricultural engineers can proceed to develop the desired storage structures and equipment. Close cooperation by the engineers with the truck crop specialists, pomologists, pathologists, physiologists, and nutrition chemists concerned would seem to be of the utmost importance in attacking these problems.

Soil erosion always has been a problem in the crop production of the southeastern states, and some work of an outstanding character has been done, notably by the North Carolina station in cooperation with the U. S. Department of Agriculture. The Alabama station has undertaken a controlled fundamental study of the important mechanical, physical, and physicochemical factors involved in the erosion of different important agricultural soils under the influence of run-off water. This research calls for both plat and laboratory studies and is aimed at the development of the basic principles governing the design of erosion prevention equipment. Naturally a knowledge of crop and soil technology is desirable in such work, and this usually can be secured best by cooperation with specialists in these lines. The fact that the U. S. Department of Agriculture is entering into a study of soil erosion and run-off prevention on a regional and national basis is evidence of the economic importance of the problem to agriculture. It offers the agricultural engineers of the southeastern states a real opportunity to participate in worth while research.

## CONCLUSION

The above brief review of the high points of the agricultural research active in the southeastern states, while obviously incomplete, nevertheless indicates some of the outstanding opportunities for agricultural engineers to participate therein in a definite and constructive manner. Many other opportunities which might have been discussed also exist in the structural and feed-processing problems incident to animal, dairy, and poultry husbandry and in the mechanical equipment problems of dairy production and manufacture. However, the above brief recital of some of the engineering problems incident to the production of the more important crops of the region would appear sufficient to indicate that it is not particularly necessary or desirable for agricultural engineers to look much beyond the programs of research existing in their own experiment stations to find ample opportunities for profitable research undertakings.

The nature of most of the opportunities for research noted also emphasizes the fact that constructive participation by agricultural engineers in much of the agricultural research of the region calls for a knowledge of and ability to use advanced physics, mechanics, thermodynamics, kinematics, electricity, and the like. Advanced training in these subjects seems desirable for research workers in the agricultural engineering of the region.

# Efficiency Not All a Matter of Size

THE very nature of farming makes the most efficient unit in that business one of much smaller relative size than in most other industries. The size of the various farm machines is much more limited than machines in other industries because most farm machines must be readily transportable and not heavy enough to injure the soil, while in a factory a single machine may weigh hundreds of tons and occupy a large amount of space, since it never has to be moved after once assembled.

In view of these and other considerations, some men who have given the problem careful consideration believe that a two-man farm with modern equipment, even if such equipment is not of the largest size available, can approximate, or perhaps equal, the lowest production costs which can be obtained on the largest farms.

Just what size of farm will permit minimum cost on any crop will, of course, depend upon a number of factors, particularly climatic and soil conditions. Under corn belt conditions, it is possible that the ideal size of farm for low-cost production is not more than one section (640 acres) of land. Some experienced and highly efficient farmers believe it may be as large as a two-section farm, with two men and modern equipment doing all the work.

In wheat farming, men whose opinions should be worth while place the ideal size from two sections to four sections and contend that farms within this range, properly equipped and managed, can compete successfully with the largest farms which can be organized.

One fact which must not be overlooked is that, on large farms, there must be superintendents who must be paid but who do no actual productive work, while, on the individually owned and operated farm, the owner attends to all business matters, does the planning, and also acts as a tractor operator. It seems doubtful whether corporation farming can ever displace farms of this type, assuming, of course, that they are managed competently.—From an editorial by Arnold P. Yerkes in the January-February issue of "Tractor Farming."

# The Combination Cushion Spring and Clutch Release Hitch[1]

By E. G. McKibben[2]

WHEN using tillage implements in stony soils it is frequently undesirable to use overload release hitches which completely disconnect the implement from the load. Even under the best of conditions an appreciable amount of time is lost in rehitching. Also, if the tillage implement is mounted directly on the tractor without wheels and a carriage frame of its own, the simple overload release hitch cannot be satisfactorily used. While it is usually possible under these conditions to give rather complete overload protection by the use of a properly selected cushion drawbar spring[3], the use of a clutch release which automatically disengages the clutch at a given drawbar pull greatly increases the capacity, of a given drawbar spring, to absorb the kinetic energy of a moving tractor. In the following paragraphs both theoretical considerations and the results of actual field trials are discussed.

The potential energy of a completely compressed drawbar spring, in inch-pounds, is

$$\frac{Fd^2}{2} \qquad [1]$$

where $d$ is the maximum elastic deformation in inches, and $F$ is the force in pounds required to deform the spring one inch.

If $P$ is the drawbar pull in pounds at which the clutch is released,

$$\frac{P}{F} \qquad [2]$$

is the distance the spring will be compressed at the time the clutch is disengaged. Substituting $(P \div F)$ for $d$ in [1]

$$\left[\frac{F}{2}\right]\left[\frac{P}{F}\right]^2 = \frac{P^2}{2F} \qquad [3]$$

which is the potential energy of the spring caused by the drawbar pull up to the point of disengaging the clutch. Thus

$$\frac{Fd^2}{2} - \frac{P^2}{2F} \qquad [4]$$

is the potential energy of the spring available for absorbing the kinetic energy of the tractor. If no clutch release is used and the maximum drawbar pull caused by traction is $T$, then

$$\frac{Fd^2}{2} - \frac{T^2}{2F} - \frac{T(d-T)}{F} \qquad [5]$$

is the potential energy of the spring available for absorbing the kinetic energy of the tractor.

Simplifying [5]

$$\frac{Fd^2}{2} + \frac{T^2}{2F} - Td \qquad [6]$$

Subtracting [6] from [4] gives

$$Td - \frac{T^2 + P^2}{2F} \qquad [7]$$

which represents the increase, resulting from the use of a clutch release, in potential energy available for absorbing the kinetic energy of the tractor.

Probably the best way to make clear the significance of these equations is to assume a simple example. Thus, if

$d = 4$ inches = the maximum elastic deformation

$F = 1350$ pounds = force required to deform the spring one inch

$P = 1500$ pounds = the drawbar pull at which the clutch is released

$T = 2000$ pounds = maximum drawbar pull caused by traction, then from [1] the potential energy of the compressed spring would be 10,800 inch-pounds; from [4] the potential energy available for absorbing the kinetic energy of the tractor when using the clutch release would be

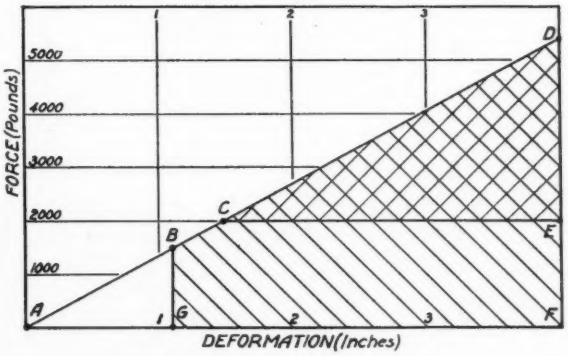



Fig. 2. Graphical solution of equations [1], [4], [6] and [7] for the drawbar spring used in the Pennsylvania field trials. Line AD is the stress-strain curve. Area ADF below line Ad represents the total potential energy of the spring when compressed. Area BDFG represents the potential energy available for absorbing the kinetic energy of the tractor with the clutch released at a 1500-pound drawbar pull. Area CDE represents the potential energy available for absorbing the kinetic energy of the tractor without clutch release and maximum drawbar pull caused by traction assumed at 2000 pounds. (This is probably low.) Area BCEFG represents gain in available potential energy resulting from clutch release

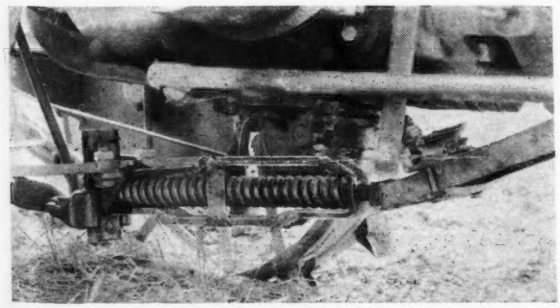


Fig. 1. Tractor and drawbar spring used in the field trials at Pennsylvania State College described by Mr. McKibben in this paper

[1] Report on an investigation in connection with a project on accessories for tractor plowing in stony ground conducted by the author at Pennsylvania State College during September, 1930. Publication authorized by the director of the Pennsylvania Agricultural Experiment Station as Technical Paper No. 517. Released for first publication in AGRICULTURAL ENGINEERING.

[2] Associate professor of agricultural engineering, Iowa State College. Mem. ASAE.

[3] "Substitute for Breakpins—Drawbar Springs"—AGRICULTURAL ENGINEERING, Vol. 9, No. 6, pages 167-170, June, 1928.

9967 inch-pounds; from [6] the potential energy available for absorbing the kinetic energy of the tractor without the clutch release would be 4282 inch-pounds; and from [6] the gain in using the clutch release would be (9967—4282), or an increase of 5685 inch-pounds of potential energy available for absorbing the kinetic energy of the tractor. This is a gain of 134 per cent. It should also be noted that, while it is possible to approximate under normal conditions the maximum drawbar pull, $T$, caused by traction, there is always the possibility that under unusually good traction conditions this value will be greatly increased, thus materially increasing the importance of a clutch release.

The above example was selected because field trials of such a spring were actually carried out. Fig. 1 shows this drawbar spring. Fig. 2, which is explained in its caption, shows graphically the same relationships as equations [1], [4], [6] and [7].

Fig. 3 shows the relation between speed and the kinetic energy of the 4350-pound tractor used in the field trials. Fig. 4 shows the relation between the deformation of drawbar spring, available potential energy, and kinetic energy of the tractor under the conditions described in the caption.

From Curves B and D of Fig. 4 it would seem probable that the drawbar spring would give fair protection to a steel plow with the tractor operating in low gear and the clutch release set to trip at 1500 pounds. Actual field trials proved this to be true.

This equipment was used in an unusually stony field. While operating in low gear the plow struck 86 stones which caused the clutch release to be tripped and the tractor stopped—stones which, in fact, required backing the tractor and lifting the plow before it was possible to proceed. Only once was a share definitely damaged and that time the clutch release failed to trip.

A further study of Fig. 4, that is, Curves B and E, would indicate that the spring shown in Fig. 1 and a clutch release tripping at 1500 pounds would not give adequate protection to even a steel plow when operated at intermediate speed. This inference was also confirmed by field trials. Every solid stone struck when operating at intermediate speed resulted in definite damage to a share, either a bent or broken point, or a large nick in the edge.

From Curves C and E it would seem logical to infer that, if two springs such as the one shown in Fig. 1 had been used in series, the protection in second gear would have been equal to or better than that given by one spring when operating in low gear. Curves A and D indicate that without a clutch release the spring (shown in Fig. 1) would fail to protect the plow even in low gear. This also checked with the field results. The only time the clutch release failed to operate when a solid stone was struck in low gear the point of the share was badly bent.

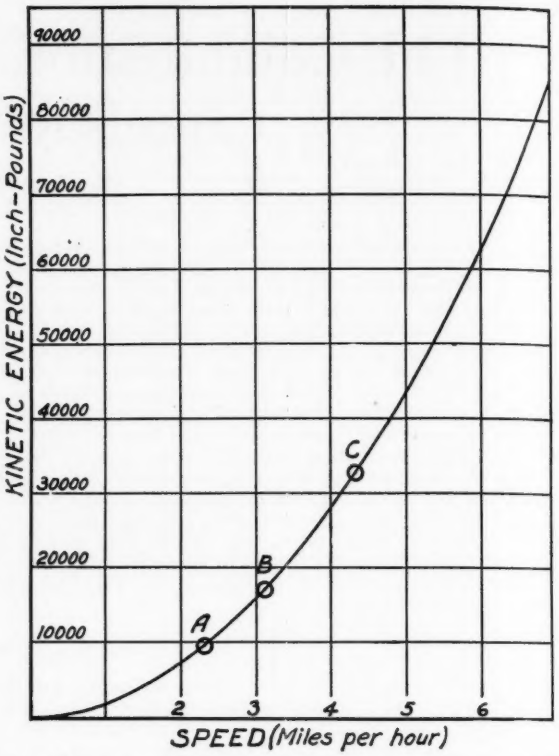



Fig. 3. Relation between speed and kinetic energy of tractor used in the Pennsylvania field trials. A, B and C speeds in low, intermediate, and high, respectively

## CONCLUSIONS

It seems probable that a combination hitch consisting of a properly selected cushion spring and a well-designed clutch release would have worthwhile possibilities for use with tillage implements in stony or obstructed soils.

The spring in such a hitch would have to have the proper stress-strain characteristics.

The overload clutch release should have as many as possible of the following characteristics:

1. Durable and replaceable wearing parts
2. Release clutch quickly without allowing it to drag
3. Accurate and convenient adjustment
4. Effect on adjustment of wear and exposure to dust and weather as small as possible
5. Reasonable first cost.

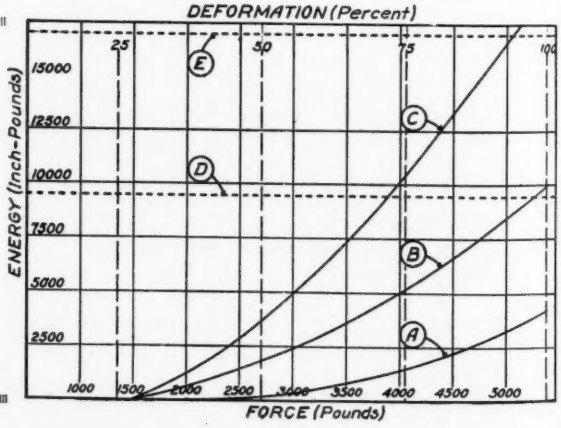



Fig. 4. (A) Curve showing, for the spring of Fig 1, the relation between deformation and the corresponding force, and potential energy available for absorbing kinetic energy of tractor when no clutch release is used and the maximum drawbar pull resulting from traction is assumed as 2000 pounds. (B) same as (A) except with clutch released at 1500 pounds. (C) same as (B) except with two springs, like that shown in Fig. 1, used in series. (D) kinetic energy of 4350-pound tractor in low gear (2⅛ miles per hour). (E) kinetic energy of 4350-pound tractor in second gear (3⅛ miles per hour)

# Corn Production Studies with the General-Purpose Tractor[1]

By R. U. Blasingame[2]

A RATHER definite plan has been adopted by the agricultural engineering department at the Pennsylvania Agricultural Experiment Station pertaining to preliminary studies upon subjects, when necessary, before formal research projects are prepared. Such studies are made to discover (1) what phase or phases of a subject require solution and (2) to develop, if possible, the engineering procedure which will bring about that solution. We have profited at our institution through the use of this plan. This paper is a brief report of our preliminary studies this season in the production of 40 acres of corn employing a three-row general-purpose tractor.

Table I shows the operations performed, and the man-hours, tractor-hours and fuel required per acre. A service recorder was used on the tractor and the fuel weighed. Table II indicates the cost of power and labor per acre.

The cost of other items, such as rent on land, insurance, taxes, machinery, seed, fertilizer, etc., remain essentially the same no matter what form of power is used.

It will be seen from Table I that the entire crop was produced with 6.65 man-hours per acre which is about the time usually required to plow land with a two-horse team.

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1930.

[2]Professor and head of the department of agricultural engineering, Pennsylvania State College. Mem. ASAE.

TRACTOR OPERATOR'S DAILY WORK RECORD

RESEARCH PROJECT No.

Operator Roy Johnson
Tractor [illegible]
Kerosene Used 6.2 Gal.
Gasoline Used 5 Gt.
Oil Used Qt.
Grease Used [illegible]

Day of Week Sunday Date 4/12/30
Weather Cloudy & High Wind
Condition of Soil Good
Seed Used
Fertilizer Used

| Time | Operation | Field No. | Machine Used | Hours | Amount of work done (acres, load, etc.) |
|---|---|---|---|---|---|
| 7:00 | | | | | |
| 7:30 | | | | | |
| 8:00 | | | | | |
| 8:30 | | | | | |
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| 4:30 | | | | | |
| 5:00 | | | | | |
| 5:30 | | | | | |
| 6:00 | Plowing | 3 | P&O Plow | | |
| | | | Total Hours | 8 | 4.5 Acres |

Remarks: Broke spring overload release hitch
Broke one plow share.

Approved R. U. Blasingame
(In Charge of Work)

Daily record sheet and (inset) section of tractor service recorder chart from which the record is taken. This system of keeping accurate records in power and machinery field research work is the most satisfactory one that Mr. Blasingame and his associates have found. It is the system which they regularly use

This record is encouraging from the economic point of view; however, certain difficulties with the cultivating equipment were encountered, some of which were anticipated.

Even though the field was quite stony and rough the three-row tractor planter gave excellent satisfaction.

The first two cultivations were made with shovels having trip shanks. During this time, ten shovels, two shovel sleeves and one center rig coupling were broken; and one outer rig standard and one center brace for the outrigger frame were bent.

The location of the pivot point of the frames carrying the cultivator rigs of two outside rows is so arranged that inequalities in the land encountered by the caster wheels, supporting the outer ends of these frames, caused a change in the distance between the cultivating shovels. This feature was particularly objectionable when attempting to cultivate close to small corn in rocky, rough ground.

When the shovels tripped as a result of striking a tight stone, it was necessary either to lift the shovels or stop and reverse the tractor in order to return the tripped shovel to its operating position.

In spite of careful adjustment these cultivators furrowed the land badly between the rows. This would increase the danger of erosion in case of heavy rains on hilly land. In order to overcome these difficulties, spring teeth and disk hillers were used to cultivate the corn the third time. This equipment gave quite satisfactory results and the last cultivation was made without breakage.

Even though there was no breakage of this spring tooth equipment, and its performance indicated its adaptability to land where tight stones occur, their condition after cultivating the 40 acres only once showed the need of either a change of material or design. These spring teeth took permanent sets, some of which were considerably away from the original shape.

In order to eliminate furrowing, small sections of weeders were built and attached to trail the cultivator in the middle of the rows. These weeders were crude and consisted of only one row of teeth. Possibly two or three would have been better. However, they practically eliminated all furrowing by the cultivator.

In order to study further the adaptability of this culti-

TABLE I. Man-Hours, Tractor-Hours and Fuel for the Production of 40 Acres of Corn With a Three-Row General-Purpose Tractor

| Operation | Man-Hours | | | | Tractor-Hours | | Kerosene | |
|---|---|---|---|---|---|---|---|---|
| | Actual operating | | Travel to field, routine servicing, field adjustments, minor field repairs | | | | | |
| | Field | Per Acre | Field | Per Acre | Field | Per Acre | Field | Per Acre |
| Plowing | 84.90 | 2.12 | 21.40 | 0.54 | 84.90 | 2.12 | 108.9 | 2.72 |
| Rolling | 10.00 | 0.25 | 1.50 | 0.04 | 10.00 | 0.25 | 20.1 | 0.50 |
| Spring-tooth harrowing | 8.25 | 0.21 | 2.25 | 0.06 | 8.25 | 0.21 | 20.4 | 0.51 |
| Liming | 7.80 | 0.20 | 1.80 | 0.05 | 3.90 | 0.10 | 5.1 | 0.13 |
| Spring-tooth harrowing | 33.60 | 0.84 | 6.90 | 0.17 | 33.60 | 0.84 | 74.7 | 1.87 |
| Rolling | | | | | | | | |
| Planting | 15.00 | 0.38 | 6.50 | 0.16 | 15.00 | 0.38 | 21.5 | 0.54 |
| Spike-tooth harrowing | 6.25 | 0.16 | 2.75 | 0.07 | 6.25 | 0.16 | 9.4 | 0.24 |
| First cultivation | 15.50 | 0.39 | 4.50 | 0.11 | 15.50 | 0.39 | 16.4 | 0.41 |
| Second cultivation | 14.75 | 0.37 | 4.25 | 0.11 | 14.75 | 0.37 | 20.6 | 0.52 |
| Third cultivation | 12.00 | 0.30 | 5.00 | 0.12 | 12.00 | 0.30 | 14.8 | 0.37 |
| Total | 208.05 | 5.22 | 56.85 | 1.43 | 204.15 | 5.12 | 311.9 | 0.81 |

**The general-purpose tractor—more versatile and adaptable than the standard farm tractor, more efficient than animal power, easily put to work and kept at work, still the object of research with a view to its further improvement**

vating equipment a three-acre plot of clover and timothy sod was planted to corn July 18, 1930. Despite the dry season the corn came up by July 23. However, due to the dry weather, this undertaking was to some degree disappointing because the field conditions as to soil moisture and weed growth were not comparable to normal cultivating seasons.

Twelve rows were weeded four times with a Babcock weeder which was built for potato cultivation and attached directly to the Farmall tractor. The loss of plants due to the last three weedings for speeds of 2, 3 and 4 miles per hour, respectively, were 4.39, 5.59 and 7.27 per cent. The loss due to the first weeding is eliminated because not all of the corn was up by this time.

The light John Deere weeder was used along with other cultivating equipment on 16 rows. The average loss of stand on these 16 rows was 1 per cent, as compared with 0.94 per cent for the 32 rows on which it was not used.

While the lack of rain and weed seeds (grass sod plowed in midsummer) prevent a satisfactory appraisal of the performance of the potato weeder, it appears that as commonly designed it is a rather severe tool for corn. However, it should not be condemned without further trial. It is entirely possible that under certain conditions the destruction of weeds would more than compensate for the loss in stand, especially if a thick stand were purposely planted and a flexible, less severe weeder designed especially for corn.

Observation during its use indicated that much of the damage was caused by stones, clods and sods dragged along by the teeth. A different spacing of teeth especially in the direction of travel might remedy this trouble to some extent. It was also evident that the weeder which covered four rows was not flexible enough.

The spring trip shovels had the same objections and gave about the same performance as when used on the 40-acre field.

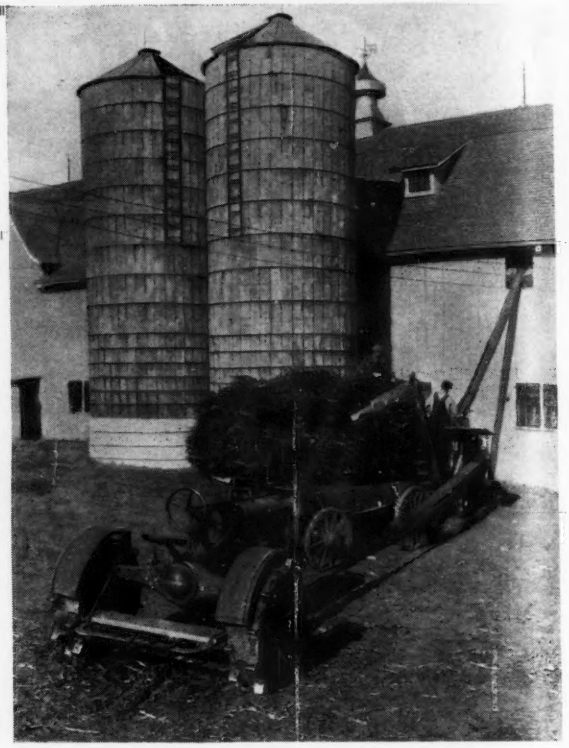
Spring-tooth cultivating equipment performed very satisfactorily except for the need of either better materials in or better design of the springs as mentioned above. Twenty-four of these teeth were used and arranged to get uniform spacing laterally and maximum spacing in the direction of travel. The front tooth on the rear left-hand rig interfered with the power lift. In production work it would either have to be left out or some change in design made.

The disk hillers appeared to be very satisfactory equipment. When cutting away from the row, it was possible to get closer to the row than with any other equipment.

**TABLE II. Cost of Power and Labor per Acre in Production of 40 Acres of Corn with a Three-Row General-Purpose Tractor**

| | |
|---|---|
| Use of tractor, 5.12 hours at 50 cents[3] | $2.56 |
| Man labor, 6.65 hours at 30 cents | 1.99 |
| Kerosene, 7.8 gallons at 14 cents | 1.09 |
| Gasoline, 0.23 gallon at 18 cents | 0.05 |
| Oil, 0.23 gallon at 50 cents | 0.12 |
| Grease, 0.13 pound at 15 cents | 0.02 |
| Total | $5.83 |

[3]Bulletin No. 238, "Farm Power and Labor." Pennsylvania Agricultural Experiment Station, 1929.



Because of their design (all teeth in one row) the experimental weeders used between the last 12 rows gave trouble by clogging with grass roots. However, if properly designed they should be of value where a very smooth cultivation is desired.

While it was very difficult to determine the minimum distance from the row which shovels could be set without either unduly taxing the driver or destroying too much corn, it appeared to be about 11 to 12 inches between shovels and about 9 to 10 inches between disk hillers when they were cutting away from the corn. If the distance between the three cultivator row centers were constant instead of changing, these distances could probably be decreased.

A formal research project is being prepared with the object of making a study of the mechanics, materials and economics in the adaptation of all-purpose tractors and equipment for corn production in Pennsylvania.

Some of the economic factors already scheduled for investigation are the time required in servicing equipment, making adjustments and minor field repair work, and the overhead cost of all-purpose tractor equipment, in operation over large acreages. Mechanical and metallurgical considerations to be studied include (1) forces resulting from cultivating equipment striking solid objects at different speeds, (2) motions required to effectively accommodate cultivating equipment to rough, irregular land, (3) metals best adapted to cultivating elements such as shovels, spring teeth, disk hillers, etc., (4) adaptation of power take-off operated steel wire and fiber brushes. Trials will also be made on rough, stony land of available equipment such as cultivating elements mounted on leaf spring shanks, weeders used both on and between the rows, and narrow, spring-mounted rotary hoe attachments constructed of spring steel.

AUTHOR'S NOTE: E. G. McKibben of Iowa State College was employed by the agricultural engineering department of the Pennsylvania Agricultural Experiment Station during the summer of 1930 and was in charge of this study. This paper was prepared largely from his report.

# General-Purpose Tractor Design[1]

By G. D. Jones[2]

THE general-purpose tractor of today is an evolution of the conventional wheel tractor long familiar to all of us. And it appears to me that it is through force of circumstance that a general-purpose tractor is now available. No development in the implement industry was regarded with more distrust, and wholesale opposition than the suggested general-purpose tractor. The design of the general-purpose tractor closely followed that of the conventional wheel tractor. The opposition came more from the implement manufacturers' home organizations than from the field, and those with vision within the organizations certainly deserve credit for their relentless efforts to have this type of tractor released for experimental development in order to prove the future worth of the unit.

Let me emphasize the fact in my statements which follow, that no criticism is directed to those responsible for the present development. My comments are thoughts for future development and design, and I trust that this development and design will receive the wholehearted cooperation of the entire agricultural field.

At the winter meeting of the tractor division of the Society of Automotive Engineers in Minneapolis in 1922, I gave my thoughts as to the general principles to be followed in the design of a general-purpose tractor, and the opposition to these thoughts was stated in no uncertain language. I made the statement that the need for a general-purpose tractor was very evident due to the trend towards motorized farming, "that the tractor should be rangy, sturdy and compact in design; and yet so simple in construction and operation that it could be easily operated after the briefest period of instruction." The tractor, I said, must be easily raised or lowered, narrowed or widened, to fit the exact conditions of the crop to be worked and the implements designed for the tractor should be easily and quickly attached and detached. Those implements requiring delicate control, such as cultivators, should be pushed ahead of the tractor.

At that time a few tractors were on the market or had just been withdrawn that could be used for plowing and cultivating, but were unstable, difficult to handle, and required special implements for the work. Some three years later a stable all-purpose tractor appeared on the market. The rear wheels were spread to straddle two rows and the tractor raised to straddle the crop, the front wheels brought in, giving the appearance of a high and wide three-wheel tractor. Some of the equipment was rigidly mounted on the front end and the balance of the implements were drawn in the regular way. Today we have on the market a number of general-purpose tractors varying slightly, if any, from this design.

This has been the one outstanding fault of the farm implement industry of late years, that is, taking what we have used for years and trying to adapt it to the modern power farm—patching patchwork, to use a very plain statement of fact.

I doubt very much if any analysis is ever made of the requirements of the various crops, the size and economical layout of the farms, before designing a tractor. Generally the size and design of the tractor is laid out by the engineering department, trusting to fit the farm to the tractor. This statement is borne out by the fact that many field changes, including power units and general design which would not have been necessary if a preliminary survey was made. Let me suggest that the designer and engineer of a tractor take it and work it as the farmer has to, not for a few trips around the field but for days, and after he has completed the job, service the unit. I venture to say that the design of power units would be materially improved, and would make better provision for comfort for the operator and ease of making machine repairs.

The fundamental factor governing tractor design is balance. In the balancing of a tractor the power unit and the transmission must be so located in relation to the driving element as to secure the greatest possible traction with the minimum loss of power. This is very evident from the slippage losses recorded in the Nebraska tests. One might say correct balance governs the success or failure of a tractor. This balancing would include the economical working of a unit at one-fourth and one-half as well as at full load.

This brings us to traction, one of the most troublesome problems of tractor design. Poor traction or slippage increases the cost of operation, the temper of the operator and the time required to do a given piece of work. Undoubtedly the design of wheels will tend to improve this condition but we must study our balance in connection therewith. There is no reason why we cannot drive each wheel independently so that as the weight shifts to either side, the spinning of one wheel by differential action would

[1]Paper presented at a meeting of the Power and Machinery Division of American Society of Agricultural Engineers, at Chicago, December, 1930.

[2]Agricultural engineer, Cleveland Tractor Company. Mem. ASAE.

Agricultural engineers are encouraging and helping farmers to reduce costs. And farmers are making good progress in this direction. An important part of the agricultural engineer's job in this effort to lower production costs is to produce the equipment that will most efficiently and economically meet farm requirements. Incidentally, they must start from the fact that the agriculture of the future will be mostly on a mechanical power basis

be eliminated. This can be done by means of a locking differential or by clutching action.

Some of the present general-purpose tractors can be widened or narrowed but none that I know of can be raised or lowered. This should be possible and should be a simple operation. The center of gravity, we all realize, should be kept low, but this is impossible in cultivating tall plants such as corn and cotton. Sugar beets and other low-growing crops do not need a unit of high clearance, so why not give the tractor owner the advantage of adjustability of height.

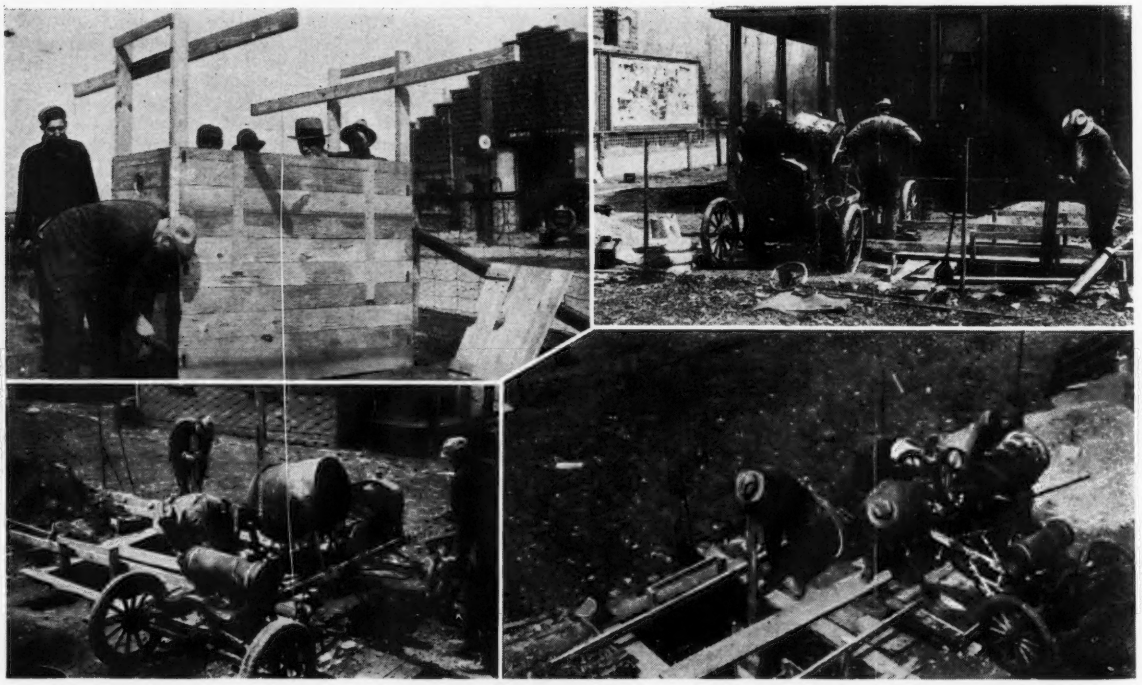
One of the most important problems, aside from balance, is visability. I have had the opportunity of operating all of the general-purpose tractors on the market and must say that the comfort of the operator has been sadly neglected. If something is not done, one will be able to pick out the future generation of general-purpose tractor operators from the curvature of the spine to the right. This statement has particular reference to the cultivating operation. A comfortable seat located on the forward part of the tractor and another seat at the rear would aid materially in eliminating this fault, and with a simple positive steering means reduce the human effort and greatly increase the operating efficiency of the unit.

My idea of the future general-purpose tractor is that it will be a completely balanced tractor with as much of the weight as possible during the pulling operation carried directly over the drivewheels, and more or less evenly distributed over the entire tractor when operating without load; with means for widening and narrowing the tread and for raising and lowering the clearance and center of gravity; complete visibility with perhaps two seats and simple, easily operated steering means.

These features might be embodied in a design which would have the general arrangement and appearance of an ordinary three-wheel, general-purpose tractor running in reverse; pushing ahead of its broad front implements for cultivating and similar operations and drawing behind it such implements as plows and harrows. This arrangement, however, would not apply the torque load to increase the effective weight on the drivewheels while pulling but would place it entirely upon the rear caster wheel.

During my recent trip through Central Asia where agriculture is carried on as it was 2,000 B.C., I saw the same type of implements used and tillage carried on in much the same manner as we are doing it today. The only difference I could see was that they used camels for motive power and wood instead of steel for the implements.

We are telling the farmer that he must reduce his costs. But he cannot cut his costs in half with his present farm implements. (I am referring now to the efficient farmer who really understands farming and there are many of them.) It is up to the agricultural engineer to have the vision to break away from the old trend of implements and strike pay dirt with implements that will cut costs and cut them materially. Let us produce a machine that will handle the seedbed preparation from plowing to seeding in one operation, including the physical and chemical treatment of the soil.



DEMONSTRATING SEPTIC TANK CONSTRUCTION IN PENNSYLVANIA

(Upper left) "Christening" a new septic tank form with crankcase oil, giving particular attention to butt ends of the boards. This helps preserve the form and makes it easier to remove after the concrete has taken its initial set. The sides and ends of this form are held together by bolts from the inside which turn into screw plates set flush with the outside. (Upper right) The septic tank being built on this community form is to serve the house in the background. Both are located on one building lot. Note that the steering wheel of the auto has been removed to permit operation of the concrete mixer. (Lower left) Close-up of auto chassis with concrete mixer mounted. To make the machine ready for the road the belt from the auto transmission drum to the mixer pulley is removed; the differential drive shaft pinned to the transmission; and the seat and steering wheel are put on. (Lower right) View showing arrangement of motorized concrete mixer, form and materials. The water tub is at the lower right

# Temperatures of Peat Soil Relative to Summer Frost Control[1]

By H. B. Roe[2], J. H. Neal[3], B. R. Colby[4] and B. C. Colby[5]

## CONCLUSIONS

1. Barometric pressure shows an opposite trend to air and surface temperatures 60 to 65 per cent of the time.
2. Trends of humidity show some tendency to follow temperature trends.
3. Rain or a rainy period tends to raise the humidity sharply but only for very short periods.
4. Cloudiness markedly restrains extremes of temperature.
5. Frost is apt to occur on the second morning following a rain or a rainy period.
6. Clear sky and northerly winds tend to predominate when the barometer is rising.
7. A clearing sky in the evening is apt to be followed by a sharp drop in temperature early the next morning.
8. A northerly and more especially a northwest wind in the afternoon is apt to be followed by a dangerously low temperature early the following morning.
9. The following phenomena or combinations of any three are fairly reliable indices of approaching frost: (a) Rising barometer, (b) low or dropping humidity, (c) a clearing sky, and (d) a northerly or especially a northwest wind.
10. Thoroughness of subdrainage of the peat soil increases the tendency to and the intensity of frost at the surface.
11. Dryness of the peat surface increases the danger of frost especially when other conditions are favorable for it.

THE phenomena considered in this study, as far as data were available, included barometric pressure, humidity, rainfall, cloudiness, wind direction, various surface and air temperature conditions and degree of drainage.

The experimental tract, frequently herein also called the "peat plots," is located, as shown in Fig. 1, a few miles west of Minneapolis, Minnesota, and close to Lake Minnetonka which lies to the north and west of it. The tract is one mile north of Excelsior Boulevard at Clear Springs station on the Minnetonka electric line.

With the exception of the rainfall and temperature record which was kept at the tract, weather observations of the Chaska and Minneapolis stations under the U. S. Weather Bureau were both considered. The Chaska station, a cooperative observer station, where the observations are taken by the American Sugar Beet Company, is the closest to the experimental tract. As this station has much the same topographic conditions, and as it lies in the same valley as does the experimental tract, its records were considered likely to conform most nearly with the conditions of the experimental tract. However, as cooperative observer stations do not take records of barometric pressure, such records were secured from the Minneapolis official station, the closest station at which complete records were available. Moreover, as these two stations lie on nearly opposite sides of the experimental tract, it seems probable that any condition existing at both stations would also hold true at the experimental tract.

The surrounding area is morainal in character. The surface is rolling, and on the hills and ridges the soil is a sandy loam while in most of the valleys and pockets there is peat. The experimental tract is located near the edge of one of the peat areas.

The general layout was as shown in plan and profile in Fig. 2. The water flow is from north to south as the north end is the high end. By means of the control weirs hereinafter described, the ground water level on each control plot was kept theoretically at the average depth desired with a transition plot as shown between each two control plots.

During 1927 and 1928 the theoretical depths of water table on the different control plots beginning at the north end were 1 foot, 2 feet, 3 feet, 4 feet and 5 feet. The most southerly control plot noted in Fig. 2, or the 6-foot control, was not added until 1929.

In 1929 the water table was held theoretically 3 feet below the surface on all controls in order to give a cropping check on results of previous seasons.

**Design of Subirrigation System.** The main tile is 8-inch sewer pipe with tightly cemented joints but opening free into each control weir box. The original grade of the main tile was uniformly 0.25 per cent, but the settlement of the tile in the soft bog has made the final grade somewhat irregular as shown in the profile in Fig. 2. However, it is still sufficient to carry the water with ample velocity.

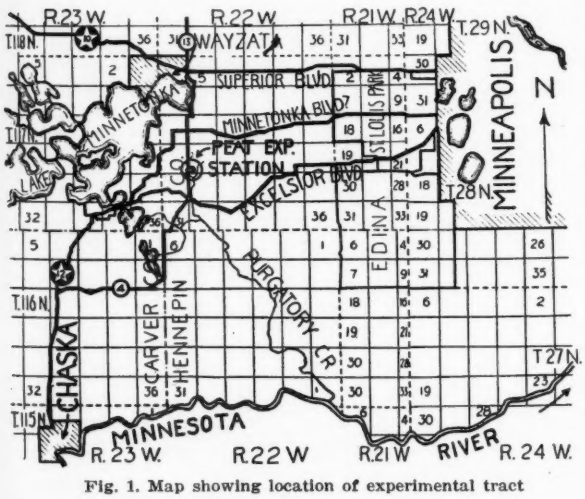



Fig. 1. Map showing location of experimental tract

[1]Journal Series Paper No. 1005 of the Agricultural Experiment Station, University of Minnesota. Released for first publication in AGRICULTURAL ENGINEERING. The full title of this paper is "A Study of the Influence of Various Meteorological Factors and of Drainage on Air and Surface Temperatures on Peat Soil with Especial Reference to Forecasting of Summer Frosts."

[2]Professor, in charge of reclamation activities, University of Minnesota. Mem. A.S.A.E.

[3]Department of Agricultural Engineering, University of Minnesota. Assoc. Mem. A.S.A.E.

[4,5]Senior students (1930) in agricultural engineering, University of Minnesota. Student assistants on this project in the Minnesota Agricultural Experiment Station. Student Mems. A.S.A.E. (Most of the actual work on this project was done and the entire original papers on it were written by them).

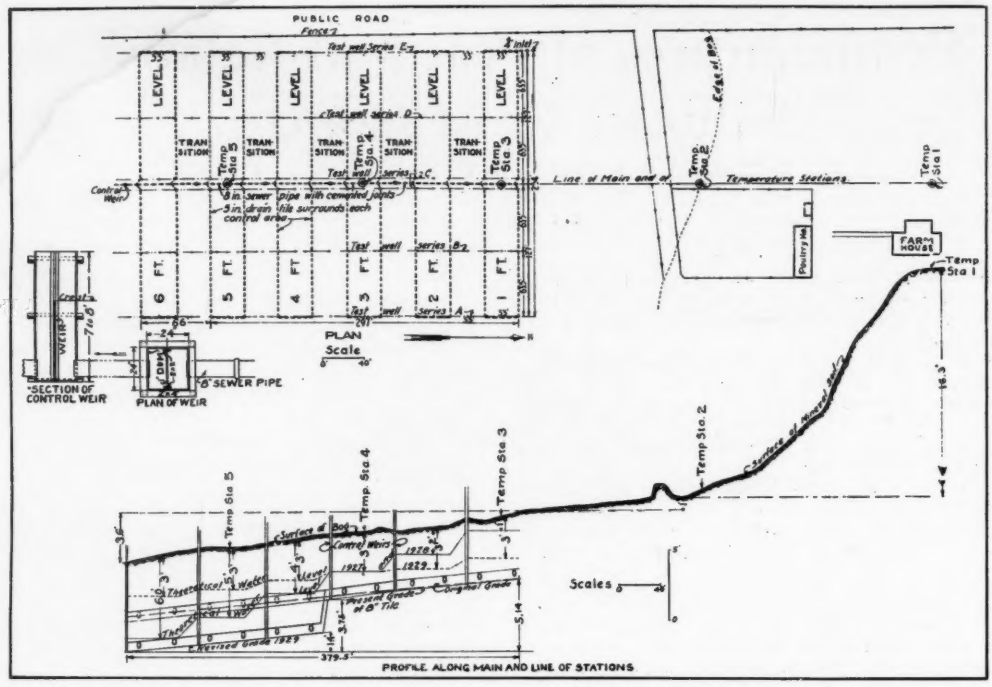



Fig. 2. Plan of experimental tract and water control works

The original depth of the base of the main tile, below the bog surface, was about 5½ to 6 feet. In the original plan, each control plot is surrounded by a loop of 5-inch drain tile laid with rather open joints at depths of from 4.5 to 6.5 feet, according to the control plot, and with a decided down grade toward the main on each loop. Owing to a general rise in the ground water level in the region in 1928, it was found necessary to lower the main tile and lower loops as shown in Fig. 2 previous to starting the investigations of 1929.

**Control Weirs.** The control of the water levels is effected by means of the weirs, the plan and locations of which are shown in Fig. 2. The weir boxes are made of good quality ¾-inch dressed and matched white pine reinforced by 2x4-inch collars. The weir aprons are of a similar material to the box wall. They are removed each fall to lower the water level before freezing up and are replaced each spring with new.

**The Inlet.** The inlet for the water supply is through a line of 4-inch tile entering the 5-inch control line at the northwest corner of the tract.

**Test Wells.** Lines of test wells in which to measure the actual height of the ground water table, are located as shown in Fig. 2. These test wells are of 4 or 5-inch drain tile and extend to a depth of 5 to 8 feet below the surface. The tops of the wells are approximately at the ground surface and each is capped with a wooden cover held in position by a small block extending down into the well.

**Soil and Subsoil.** The surface soil of the tract is a high lime peat. The peat in the northeast corner and including all the east half of the 1-foot control is thin, varying from a depth of about one foot in this corner to a depth of 4 or 5 feet near the north and south center line of the tract and is underlaid with a fine white sand. The western half of this control is not affected by these conditions, but corresponds to the rest of the tract. The peat under most of the tract is underlaid by marl at a depth of from 3½ to over 16 feet below the surface.

**Temperature Stations.** In 1928 and 1929 there were five stations, located as shown in Fig. 2, at which air and surface temperatures were taken. Previous to 1928 only Stations 3, 4 and 5 were available. Temperature station No. 1 was located at the crest of the sandy ridge on which the farm house stands. As the general biological soil and drainage conditions surrounding these stations may have had some influence on the manner of their functioning, these conditions are noted as follows:

Station No. 1 was located in a strawberry patch on the summit of the sandy ridge running east and west, with a scattered fringe of trees to the north of it. The natural drainage at this point is excellent.

Station No. 2 was located at the base of the sandy ridge at the edge of the peat bog. In 1928 this station was in a strawberry bed, while in 1929 alfalfa hay grew around it. The drainage at this point is good.

Stations Nos. 3, 4 and 5, located on the bog in the middle

TABLE I
SEASONAL AVERAGE OF BAROMETRIC PRESSURE
(Local Readings in Inches)

| Year | 4 a.m. | 12 m. | 6:47 p.m. |
|---|---|---|---|
| 1927 | | | 28.95 |
| 1928 | 28.92 | 28.93 | 28.91 |
| 1929 | 29.01 | 29.02 | 28.98 |

TABLE II
EXTREMES OF BAROMETRIC PRESSURE

| | Maxima | | | Minima | | |
|---|---|---|---|---|---|---|
| Year | Day | Hour | Reading | Day | Hour | Reading |
| 1927 | Sept. 27 | 6:47 p.m. | 29.39 | Sept. 30 | 6:47 p.m. | 28.34 |
| 1928 | Oct. 13 | 12 m. | 29.39 | June 12 | 6:47 p.m. | 28.32 |
| 1929 | Sept. 18 | 4 a.m. | 29.36 | June 27 | 6:47 p.m. | 28.57 |
| | Oct. 8 | 12 m. | 29.36 | | | |

TABLE III

APPROXIMATE TREND OF MINIMUM TEMPERATURES, REFERRED TO THOSE ON THE ONE-FOOT CONTROL, SEASONAL RANGE OF MINIMA OF EACH TYPE AND CORRESPONDING SEASONAL AVERAGE DEPTH OF WATER-TABLE

| Kind of Record | 1927 Variation from 1-Ft. Control: 1-ft. control | 1-ft. control | 3-ft. control | 5-ft control | 1927 Seasonal Range of Minimum Temperatures | 1927 Seasonal av. depth of water table | 1928 Variation from 1-Foot Control: Hill | Edge of Bog | 1-ft. control | 3-ft. control | 5-ft. control | 1928 Seasonal Range of Minimum Temperatures | 1928 Seasonal av. depth of water table | 1929 Variation from 1-Foot Control: Hill | Edge of Bog | 1-ft. control | 3-ft. control | 5-ft. control | 1929 Seasonal Range of Minimum Temperatures | 1929 Seasonal av. depth of water table |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low Air Minima | 0° | | | | June 29, 69.2° to Oct. 14, 21.6° | 1.23 | +3° to +5° | +2° | | | | July 7, 66.8° to Sept. 26, 21.1°<br>Aug. 15, 61.3° to Sept. 26, 20.6° | | +5° to +6° | +2° to +3° | | | | July 25, 59.7° to Sept. 18, 25.0° | |
| | | 1° | | | June 29, 70.2° to Oct. 14, 21.6° | 2.90 | | | 0° | -2° | | Aug. 15, 63.3° to Sept. 26, 18.1°<br>Aug. 15, 64.0° to Sept. 25, 19.0° | 1.60<br>3.07 | | | 0° | | | July 25, 57.2° to Sept. 18, 22.1°<br>Aug. 21, 59.8° to Sept. 18, 22.6° | 3.26°<br>2.85° |
| | | | -2° to -3° | | June 29, 70.2° to Oct. 14, 18.6° | 3.91 | | | | | -2° | No record to Sept. 26, 19.9° | 4.38 | | | | 0° to -2° | -1° | June 17, 64.2° to Sept. 18, 21.6° | 2.87° |
| Low Surface Minima | 0° | -1° to -3° | -0.1° to -3° | | Sept. 13, 64.2° to Oct. 14, 29.4°<br>May 16, 30.3° to Sept. 13, 63.7°<br>Sept. 13, 63.2° to Oct. 14, 29.4° | 1.23<br>2.90<br>3.91 | +3° to +6° | +3° to +6° | 0° | -2° | -2° | Aug. 15, 65.2° to Sept. 26, 34.9°<br>Aug. 15, 65.8° to Sept. 26, 33.9°<br>Aug. 15, 63.2° to Sept. 26, 26.7°<br>Aug. 15, 64.0° to Sept. 26, 26.0° | 1.60<br>3.07<br>4.38 | +4° to +8° | +2° to +4° to July 15. +7° to +2° July 15. to Sept. 12. +14° to +7° Sept. 12 to Oct. 15 | 0° | 0° to -1° | -1° | July 25, 64.9° to Sept. 18, 32.0°<br>July 25, 66.6° to Sept. 18, 43.7°<br>Aug. 21, 59.8° to Sept. 18, 28.6°<br>July 23, 58.7° to Sept. 18, 27.6°<br>Aug. 21, 60.8° to Sept. 18, 27.5° | 3.26<br>2.85<br>2.87 |
| High Air Minima | 0° | About 0° | About 0° | | June 30, 74.2° to Oct. 13, 34.9°<br>June 30, 74.2° to Oct. 13, 32.1°<br>June 30, 73.7° to Oct. 13, 35.8° | 1.23<br>2.90<br>3.91 | +1° to +2° | About 0° | 0° | +1° to July 15 6° after July 15 | About 0° | July 17, 76.3° Sept. 27, 34.9°<br>July 17, 75.3° to Sept. 27, 31.6°<br>July 17, 73.3° to Sept. 27, 35.3°<br>July 17, 74.9° to Sept. 27, 32.1°<br>No record to Sept. 27, 34.9° | 1.60<br>3.07<br>4.38 | +2° | 0° to +2° | 0° | +1° | +2° to +3° | Sept. 3, 72.7° to Sept. 19, 27.0°<br>July 27, 71.2° to Oct. 1, 35.0°<br>Sept. 3, 71.3° to Oct. 3, 34.5°<br>Sept. 3, 71.1° to Oct. 3, 33.2°<br>Sept. 3, 71.2° to Oct. 3, 33.3° | 3.26<br>2.85<br>2.87 |
| High Surface Minima | 0° | About 0° | About 0° | | June 30, 72.2° to Oct. 14, 36.9°<br>June 30, 72.2° to Oct. 13, 36.9°<br>June 30, 72.2° to Oct. 13, 36.5° | 1.23<br>2.90<br>3.91 | +3° to +4° | +2° to +3° | 0° | About 0° | +2° to +3° | July 17, 70.8° to Sept. 27, 40.8°<br>July 17, 74.2° to Sept. 27, 41.3°<br>July 17, 74.2° to Sept. 27, 36.9°<br>July 17, 76.6° to Sept. 27, 36.0°<br>July 17, 74.9° to Sept. 27, 35.2° | 1.60<br>3.07<br>4.38 | +4° | +1° to -1° to July 15. +6° " 1°. to Sept. 5. +3° to +1° after Sept. 5. | 0° | +1° | +2° to +3° | Sept. 3, 74.5° to Sept. 19, 34.6°<br>June 7, 49.4° to July 27, 73.6°<br>Sept. 3, 71.8° to Oct. 3, 39.7°<br>Sept. 3, 72.8° to Oct. 3, 39.8°<br>Sept. 3, 71.9° to Oct. 3, 40.6° | 1.26<br>2.85<br>2.87 |

*Please note that in 1929 the depth of the water table was practically uniform over the entire experimental bog.

of the 1, 3 and 5-foot controls had actual average depths to water table for the three season as follows:

| No. 3 | No. 4 | No. 5 |
|---|---|---|
| 1927....1.2 feet | 1927....2.9 feet | 1927....3.9 feet |
| 1928....1.6 feet | 1928....3.1 feet | 1928....4.4 feet |
| 1929....3.3 feet | 1929....2.9 feet | 1929....2.9 feet |

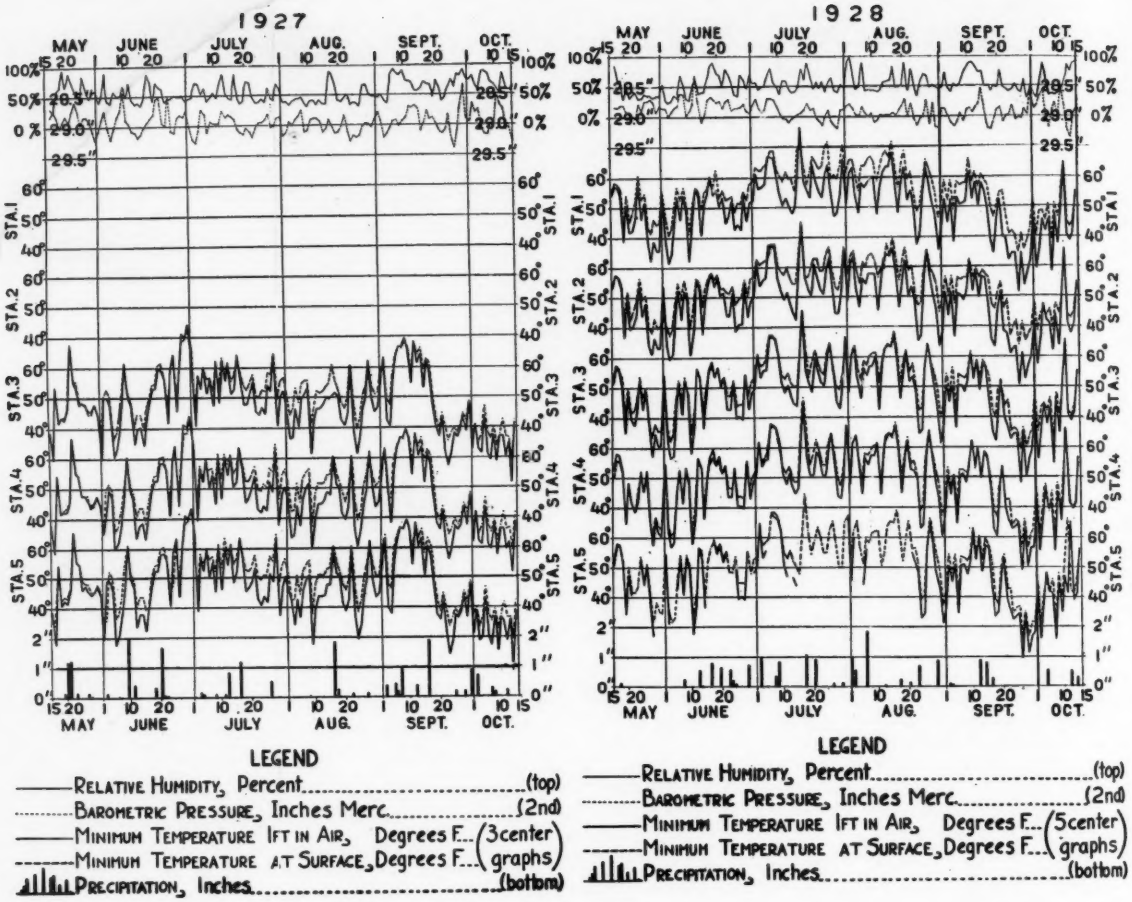
Maximum and minimum temperatures in air at 1 foot above the surface, and at the surface, were taken daily at each of the five stations for the season during which each station was in existence, using two Tycos maximum and minimum thermometers at each station. These were placed in shelters similar to those used by the U. S. Weather Bureau to shelter their instruments. One of the two thermometers was placed on a wooden table 1 foot

TABLE IV

APPROXIMATE TREND OF MAXIMUM TEMPERATURES, REFERRED TO THOSE ON THE ONE-FOOT CONTROL, SEASONAL RANGE OF MAXIMA OF EACH TYPE AND CORRESPONDING SEASONAL AVERAGE DEPTH OF WATER-TABLE

| Kind of Record | 1927 Variation from 1-Ft. Control: 1-ft. control | 1-ft. control | 3-ft. control | 5-ft. control | 1927 Seasonal Range of Maximum Temperatures | 1927 Seasonal av. depth of water table | 1928 Variation from 1-Foot Control: Hill | Edge of bog | 1-ft. control | 3-ft. control | 5-ft. control | 1928 Seasonal Range of Maximum Temperatures | 1928 Seasonal av. depth of water table | 1929 Variation from 1-Foot Control: Hill | Edge of bog | 1-ft. control | 3-ft. control | 5-ft. control | 1929 Seasonal Range of Maximum Temperatures | 1929 Seasonal av. depth of water table |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low Air Maxima | A general tendency to increase with the depth of control, but very many exceptions | | | | May 28, 53.3° to June 30, 101.8°<br>May 28, 53.0° to Sept. 11, 101.9°<br>May 28, 53.9° to Sept. 2, 92.9° | 1.23<br>2.90<br>3.91 | No general trend | No general trend | 0° | 3-ft. & 5-ft. controls keep close together occasionally -1° to -2° | | July 30, 91.8° to Oct. 13, 52.3°<br>July 12, 92.7° to Oct. 13, 52.8°<br>July 22, 88.1° to Oct. 13, 53.3°<br>July 5, 91.0° to Oct. 13, 47.9°<br>July 5, 92.8° to Oct. 13, 47.7° | 1.60<br>3.07<br>4.38 | 0° | 1° to 0° | 0° | 0° | 0° | Aug. 31, 91.1° to Oct. 10, 35.7°<br>Aug. 31, 88.2° to Oct. 10, 44.7°<br>July 25, 89.9° to Oct. 10, 45.8°<br>Sept. 2, 93.1° to Oct. 10, 44.8°<br>Aug. 9, 89.4° to Oct. 10, 43.8° | 3.26°<br>2.85°<br>2.87° |
| Low Surface Maxima | 0° | +3° July & Aug. only | +3° July & Aug. only | | June 28, 92.2° to Sept. 21, 53.3°<br>May 28, 53.3° to Sept. 12, 89.4°<br>May 28, 52.0° to June 29, 91.8° | 1.23<br>2.90<br>3.91 | About 0° to July 1. +2° to +4° after July 1 | About 0° to July 1. -2° to -4° after July 1 | 0° | +1° to +2° | About 0° | Aug. 8, 89.5° to Oct. 13, 51.3°<br>July 15, 89.4° to Sept. 25, 50.8°<br>July 2, 85.6° to Sept. 26, 99.8°<br>July 15, 92.7° to Oct. 13, 46.1°<br>July 6, 93.1° to Oct. 13, 48.0° | 1.60<br>3.07<br>4.38 | About 0° | +2° to +4° to Sept. 1 +8° to +10° after Sept. 1 | 0° | Generally 0° on both 3-ft. & 5-ft. controls with occasional fluctuations of ±1° | | June 12, 48.5° to Aug. 31, 85.3°<br>Aug. 31, 86.7° to Sept. 13, 50.6°<br>July 25, 85.6° to Oct. 10, 45.8°<br>Aug. 31, 86.2° to Oct. 10, 45.3°<br>Sept. 1, 87.4° to Oct. 10, 45.9° | 3.26<br>2.85<br>2.87 |
| High Air Maxima | Same general trend as under Low Air Maxima (See note above) | | | | June 28, 103.8° to Oct. 7, 69.0°<br>June 28, 107.3° to Oct. 8, 70.9°<br>May 30, 70.9° to June 28, 109.3° | 1.23<br>2.90<br>3.91 | +4° to +10° variation extremely irregular | +2° to +7° variation extremely irregular | 0° | No general trend on either the 3 ft. or 5 ft. control | | Aug. 8, 110.1° to Sept. 27, 73.8°<br>July 25, 109.8° to Sept. 27, 68.6°<br>June 23, 92.9° to Aug. 8, 107.3°<br>July 25, 105.5° to Sept. 21, 71.0°<br>Aug. 7, 108.6° to Sept. 13, 77.9° | 1.60<br>3.07<br>4.38 | About 0° | -1° to 0° | 0° | 0° | 0° to +1° | July 22, 97.7° to Sept. 19, 66.7°<br>July 22, 96.6° to Sept. 29, 66.7°<br>July 22, 97.3° to Sept. 29, 64.8°<br>July 22, 97.1° to Sept. 29, 67.8°<br>July 22, 99.8° to Oct. 2, 69.9° | 3.26<br>2.85<br>2.87 |
| High Surface Maxima | 0° | Same as under Low Surface Maxima (See note above) | | | June 28, 92.2° to Oct. 7, 64.1°<br>June 28, 95.4° to Oct. 7, 64.7°<br>June 28, 94.1° to Sept. 30, 63.8° | 1.23<br>2.90<br>3.91 | +2° to +6° | -2° to -4° | 0° | 0° | +1° to +2° | July 25, 100.6° to Sept. 27, 59.8°<br>July 14, 91.7° to Sept. 27, 56.8°<br>July 25, 97.8° to Sept. 30, 70.9°<br>July 7, 95.2° to Sept. 20, 71.9°<br>July 25, 94.1° to Sept. 27, 66.1° | 1.60<br>3.07<br>4.38 | 0° to -2° | -3° to -4° to Sept. 1. +6° to +10° after Sept. 1 | 0° | Same trend as under Low Surface Maxima (See note above) | | Sept. 3, 91.3° to Sept. 19, 64.5°<br>June 10, 91.7° to Sept. 19, 68.2°<br>July 22, 92.2° to Oct. 1, 66.8°<br>Sept. 15, 68.4° to Sept. 23, 64.2°<br>June 10, 93.9° to Oct. 1, 68.8° | 3.26<br>2.85<br>2.87 |

*Please note that in 1929 the depth of the water table was practically uniform over the entire experimental bog.


1927
1928
MAY JUNE JULY AUG. SEPT. OCT.
STA.1
STA.2
STA.3
STA.4
STA.5
LEGEND
Relative Humidity, Percent (top)
Barometric Pressure, Inches Merc. (2nd)
Minimum Temperature 1ft in Air, Degrees F. (3 center graphs)
Minimum Temperature at Surface, Degrees F. (3 center graphs)
Precipitation, Inches (bottom)
Relative Humidity, Percent (top)
Barometric Pressure, Inches Merc. (2nd)
Minimum Temperature 1ft in Air, Degrees F. (5 center graphs)
Minimum Temperature at Surface, Degrees F. (5 center graphs)
Precipitation, Inches (bottom)

Figs. 3 (left) and 4 (right). Trends of minimum temperatures, relative humidity, barometric pressure, and amount and distribution of precipitation

above the peat surface, and the other was set on the surface. Each thermometer was set at an angle of about 15 degrees with the horizontal.

**Local Humidity Stations.** Besides the temperature records, continuous humidity records were obtained at Stations 3 and 5 late in the fall of 1928 and during the season of 1929, continuous recording Bristol psychrometers, Class 3, being used.

**Limits of Observation Seasons.** The seasonal periods of observation were as follows:

1927.....May 16 to October 16, inclusive
1928.....May 16 to October 16, inclusive
1929.....May 29 to October 10, inclusive.

## LOCAL OBSERVATIONS AND OTHER PERTINENT METEOROLOGICAL DATA

**Barometric Trends.** The record of daily standard readings of barometric pressure at the Minneapolis weather bureau station at 6:47 p.m. local time was used as the basis of this study for each season. Daily readings for 4:00 a.m. and 12:00 noon during 1928 and 1929 taken from the complete barograph record at Minneapolis were also compared with the standard. The local observed readings in inches, without reducing to sea level values, were used in all cases.

Averages through the last half of May, for June, July, August, September, and the first half of October, for each of the three times of the day for 1928 and 1929, and the average through the same period for the 6:47 p.m. readings of 1927 are shown in Table I.

A study of the complete barometric record for the periods noted in Table I showed the following points of interest: There is a definite tendency toward a lower barometric pressure at the 6:47 p.m. reading and a higher pressure at the noon reading than at other times, this tendency being noticeable almost daily. When the barometric movement is upward, the rise from early morning

TABLE V
SUMMER FROSTS
(June to Sept., Incl.,-Temperatures One Foot in Air)

| 1927 | | 1928 | | 1929 | |
|---|---|---|---|---|---|
| Date | Lowest for Day | Date | Lowest for Day | Date | Lowest for Day |
| June 1 | 29.4 | June 2 | 31.0 | June 3 | 31.7 |
| " 5 | 27.6 | " 3 | 27.0* | " 8 | 31.0 |
| " 6 | 30.5 | " 4 | 32.1* | | |
| | | " 10 | 27.5 | | |
| July | | July | | July | |
| Aug. 9 | 27.6 | Aug. 31 | 30.5* | Aug. | |
| " 24 | 29.4 | | | | |
| Sep. 22 | 31.0 | Sep. 18 | 30.5* | Sep. 5 | 31.7 |
| " 23 | 24.1 | " 23 | 31.0* | " 14 | 31.0 |
| " 24 | 28.8 | " 26 | 18.1 | " 16 | 30.9 |
| | | " 27 | 31.6 | " 18 | 21.6 |
| | | " 28 | 30.1 | " 19 | 22.6 |
| | | " 29 | 26.1 | " 20 | 22.6 |
| | | " 30 | 26.5 | " 30 | 26.6 |

*No reading on the 5 ft. control which is usually about 1° colder.

TABLE VI

AVERAGES OF TEMPERATURE READINGS ON THOSE MORNINGS WHEN FROST OCCURRED, OR WHEN THE TEMPERATURE WAS VERY CLOSE TO FREEZING

| Station | 1927 | | | 1928 | | | 1929 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Air | Surf. | Diff. | Air | Surf. | Diff. | Air | Surf. | Diff. |
| #1 | | | | 31.71 | 41.55 | 9.84 | 33.16 | 41.55 | 8.39 |
| #2 | | | | 30.15 | 39.32 | 9.17 | 30.91 | 47.89 | 16.98 |
| #3 | 31.07 | 37.24 | 6.18 | 28.06 | 34.82 | 6.76 | 28.78 | 34.59 | 5.81 |
| #4 | 30.14 | 36.27 | 6.13 | 27.93 | 32.37 | 4.44 | 29.20 | 34.14 | 4.94 |
| #5 | 28.79 | 36.34 | 7.55 | 27.58* | 32.22* | 3.64* | 28.00 | 34.36 | 6.36 |

*Because a thermometer failed to function a part of the time at station #5 these indicated averages are of a smaller number of instances.

to noon, as a rule, is noticeably greater than that from noon to early evening. When the movement is downward, the fall from noon to early evening is, usually, noticeably greater than from early morning to noon. At times of steady pressure the trend of daily variation is indicated by the seasonal average.

In all cases a study of the monthly averages of barometric pressure shows a similar relation between readings at the three times of day to that just discussed. In 1928 and 1929 the average pressures in July were higher than those in June, and this rising trend continued into September although not so pronounced in September.

During midsummer there seems to be some tendency toward variation in more or less definite cycles of about five days, but during May and early June, and in September and October, the daily pressures fluctuate irregularly.

The maximum observed range of barometric pressure is therefore 1.07, which occurred within the growing season of 1928. Table II indicates that the maximum pressure usually occurs late in the season, while the tendency of the minimum is not so apparent. The fact that the minima occur at 6:47 p.m. and the maxima at noon in two years out of three, or in one case at 4:00 p.m., seems to bear out the previously noted relation between the pressures at the various times of day.

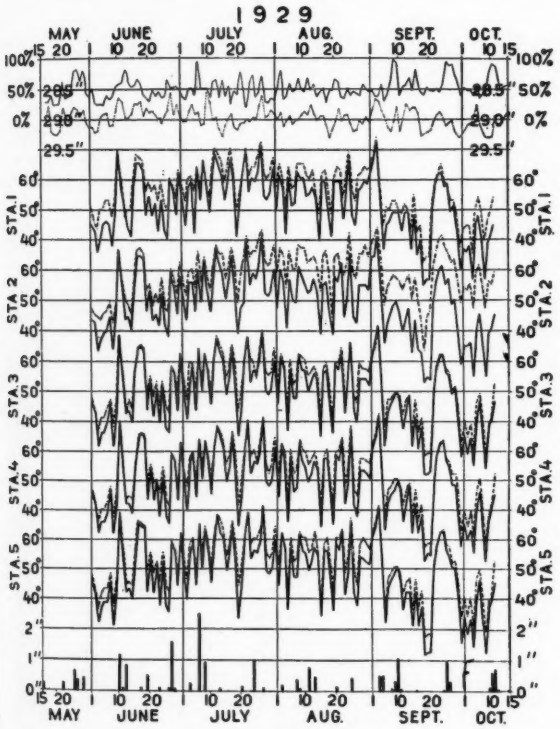



Fig. 5. Trends for 1929, corresponding to those for 1927 and for 1928 (Figs. 3 and 4)

## TRENDS OF TEMPERATURE WITH ESPECIAL REFERENCE TO MAXIMA AND MINIMA

As temperature Station No. 1 (Fig. 2) did not exist in 1927 and as degree of drainage is a principal consideration in this study, all comparisons of temperatures are made with the temperature records from the one-foot control on the experimental tract, this control plot being representative of a condition of poor drainage. Tables III and IV indicate the general trend of the minimum and maximum temperatures while Figs. 3 to 8 show clearly what is meant by low and high minima and maxima.

In each of these figures it should be noted that the general character of all the curves shown is the same, a pronounced low or high on any given curve having its counterpart on each of the other curves on the same date and differing only in intensity.

The breaks in the minimum and maximum charts for 1928 on the 5-foot control were caused by failure of the indicators on one thermometer to work properly. Except as otherwise noted, the discussion immediately following relates to the temperatures one foot above the surface.

A study of Tables III and IV and Figs. 3 to 8 justifies the following comments:

The general trend of temperatures is upward until July 1. After this the general level remains quite con-

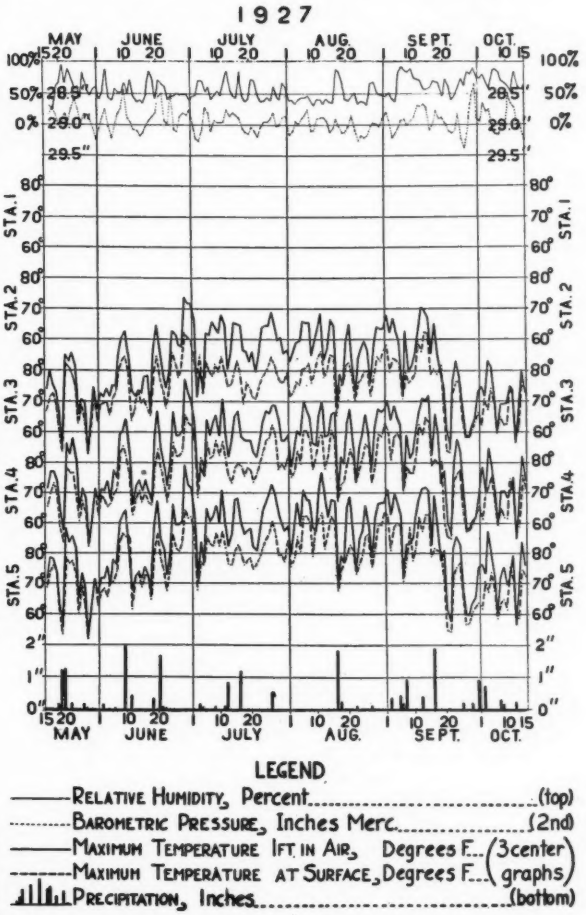
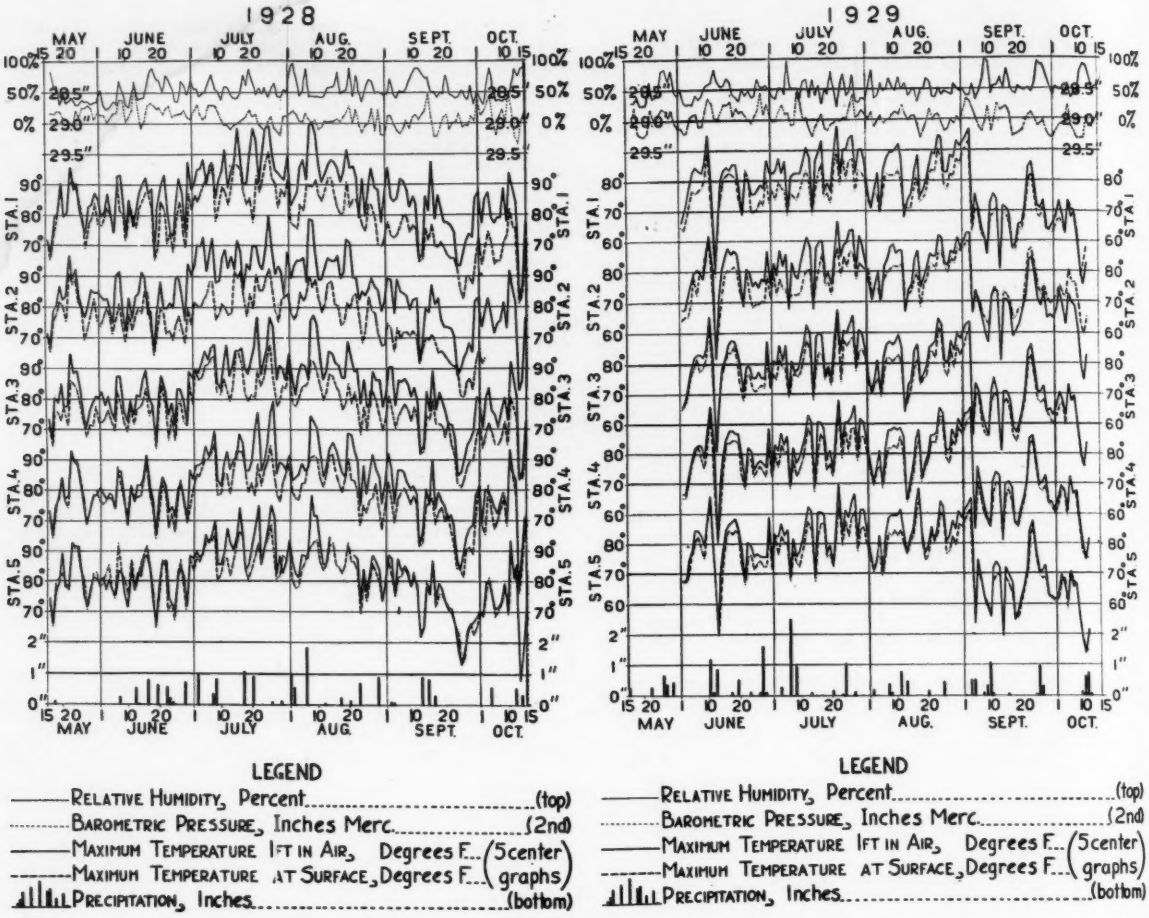



Fig. 6. Trends of maximum temperatures, relative humidity and barometric pressure, and amount and distribution of precipitation for 1927




Figs. 7 (left) and 8 (right). Trends for the years indicated, corresponding to those for 1927 (Fig. 6.)

stant until about September 10, followed by a downward trend from there on until the close of the season.

During the entire season fluctuations of considerable magnitude are continually taking place. After a day on which the minimum is lower than on either of the adjoining days, a period of two to twelve days elapses before the next low minimum occurs. A similar interval occurs between high maximum temperatures. The variableness of barometric and wind conditions together with cloudiness and precipitation seem to be the limiting factors in the length of time intervening between successive peaks or depressions in the curves of either maxima or minima.

While as great changes in temperature may take place at one time of the season as at another, and in spite of the fact that the general level of temperatures was about as high in August and the early part of September as it was in July, yet, in the three years studied, there were less decided drops of minimum temperatures to low levels in July than in any other equal length of time.

The greatest drops in maximum temperatures usually occur during or just after a rain. The minimum temperatures show the same tendency to a lesser degree. In this connection it is noted that a drop of five or more degrees in the minimum temperatures frequently takes place the second day following a rain. This was especially true in the year 1929.

A low maximum follows a low minimum. That is, when a low minimum temperature occurs in the early morning, the maximum temperature for that day is also quite low. During a period of high maxima, the minima are frequently high also, but this is not always the case as shown by the fact that within a three or four-day period, the daily difference between the maxima and minima sometimes varies as much as 56 degrees. For example, in September 1927 the difference between the maximum and minimum was 56.2 degrees on September 4, but only 8.7 degrees on September 6. There are many less pronounced instances of similar character.

A maximum temperature of 100 degrees or more was recorded quite frequently in each season. At any time in the season, the maximum temperature may exceed 85 degrees on a clear day. This occurred as early as on May 19 and as late as October 10, 1928. Moreover, a minimum of 30 degrees may occur at any time with the possible exception of the latter half of June, and the entire month of July (Table V).

A drop of 30 degrees in the maximum temperature occasionally takes place from one day to the next while the extreme drop in the minima is somewhat less. The rises in equal intervals are nearly as great.

The temperatures at the ground surface show the same general trends as do those of the air one foot above the ground, except that the maxima do not rise as high or the minima fall as low as they do above the surface.

In general it appears that on cold nights the widest spread between air and surface temperatures occurs on the 5-foot control. Throughout the study it is apparent that the spread between air and surface temperatures is much smaller for high than for low minima, and that this spread is greater on the hill and at the edge of the bog than it is on the peat. In support of the above conclusions refer to Table VI.

(To be concluded in the April number)

# Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

**Erosion and Silting of Dredged Drainage Ditches,** C. E. Ramser (U. S. Department of Agriculture, Technical Bulletin 184 (1930), pp. 55, pls. 22, figs. 24).—The results of observations and cross-sectional and hydraulic measurements made between 1913 and 1921 on 22 dredged drainage ditches in Mississippi, Tennessee and Iowa are reported.

It was found that little erosion of alluvial clay soil occurs where the velocity is much less than 3 feet per second. The greatest erosion in a channel occurs in connection with the maximum velocity. In the absence of backwater conditions the maximum velocity in a channel occurs with the highest stage. Silt is transported by a stream in suspension and by rolling along the bottom. It is believed, however, that rolling plays a minor part in the movement of silt in most drainage ditches.

It appeared that both erosion and silting took place in many of the channels and that silting occurred where the normal velocity was much greater than that obtained by the Kennedy formula for the particular depth. Even though the conditions of caving banks and growth of vegetation were eliminated by proper side slopes and systematic maintenance, it is not believed that Kennedy's formula would be applicable to the design of drainage channels where there are generally such great variations in the velocity. It was also found that the highest velocities are not always in the channels with the greatest fall.

Data are also presented on conditions affecting erosion and silting in a channel and a practical application of the results is described.

**Mechanical Refrigeration of Milk in a Tank Type Refrigerator,** F. E. Price, C. J. Hurd, and G. V. Copson (Oregon Station (Corvallis) Bulletin 268 (1930), pp. 27, figs. 10).—The results of experiments, conducted by the station in cooperation with the Oregon Committee on the Relation of Electricity to Agriculture, on milk cooling by mechanical means are reported. The experiments were applicable to the dairy farm where milk is marketed in 5 or 10-gallon cans.

It was found that milk in 10-gallon cans will cool from 95 to 60 F or below in 1 hour and to 56 F in 2 hours when set in 35 to 40-degree water. When the milk is precooled with a tubular surface cooler to 67 F it will cool to 55 F in 1 hour and to 52 F in 2 hours in 10-gallon cans when set in 35 to 40-degree water. Milk in 10-gallon cans will cool from 95 F to below 50 F in 1 hour and to 42 F in 2 hours when set in 35-degree water that is circulated around the cans. When the milk is precooled with a tubular surface cooler to 67 F it will cool to 44 F in 1 hour and to 42 F in 2 hours in 10-gallon cans when set in circulated water at 35 F. The bacterial content of milk will not increase during the first 12 hours when kept in 10-gallon cans in a tank of 35 to 40-degree water. Stirring milk in 10-gallon cans set in 35 to 40-degree water does not materially increase the rate of cooling.

Three inches of corkboard or its equivalent should be used in insulating a dairy refrigerator box. The annual average power requirement to cool 100 pounds of milk below 50 F in an insulated-tank type cooler is approximately 1 kilowatt-hour. It is less expensive to cool milk below 50 F in a tank type cooler with mechanical refrigeration using electricity at 3 cents per kilowatt-hour than with ice at 0.5 cent per pound.

Plans are given for an insulated concrete milk-cooling tank.

**Fuels Used for Cooking Purposes in Indiana Rural Homes,** M. Rapp (Indiana Station (La Fayette) Bulletin 339 (1930), pp. 32, figs. 14).—The results of a questionnaire survey of fuels used for farm cooking in Indiana are reported, indicating that coal, wood and kerosene are the most important.

Laboratory studies of the thermal efficiency of cooking fuels showed the percentage of efficiency with surface burners to be as follows: Coal 5.3 per cent, kerosene 33.5, gasoline 40.3, artificial gas 51, and electricity 83.3 per cent.

In the preparation of a meal using different methods for cooking, with all fuels used there was little difference in the amount of fuel required in cooking by means of the oven or by means of surface burners. The use of a pressure cooker or of a waterless cooker in the preparation of the meal saved an appreciable amount of fuel as compared with other methods. With the coal stove the saving in fuel with the use of these cookers was considerably less than with kerosene, gasoline and electric stoves. The use of insulated electric cookers resulted in a saving of more than 60 per cent in the amount of electricity consumed as compared with the amount consumed when using oven or surface burner methods.

From the standpoint of cleanliness, control of heat and comfort for use in summer months, electricity was shown to be a most desirable cooking fuel for farm use. While the cost of operating electric stoves, with the cooking rates now available in many Indiana rural communities, was shown to be slightly higher than with other cooking fuels, this study seems to indicate that the higher operating cost with electricity was compensated by a most appreciable saving in the time required in care and cleaning of stoves.

**Relation of Dust Fungicides to Flow of Small Grains Through Drills and to Drill Injury,** R. W. Leukel (U. S. Department of Agriculture Circular 119 (1930), pp. 10).—The results are reported of experiments on the effect of various dusts on the flow of grain through grain drills and on the drill itself, and on the added effect of atmospheric moisture and rain. These results indicate that while some of the fungicidal dusts used retarded the flow of grain through the drill more than others under the conditions of the experiment, none of them caused a sufficient decrease in the quantity of dry dusted grain sown to affect appreciably the acre-yield or to necessitate any change in the setting of the drill when sowing above 6 pecks per acre.

It was found that dry dusted wheat flows through the drill more readily and requires less change in the drill setting than wheat which has been subjected to the wet formaldehyde treatment and sown while still slightly wet. This is shown by the greater decrease in the flow of moistened wheat. The reduction in stand due to seed injury commonly caused by formaldehyde also must be considered in this comparison. In fact, according to the results obtained, dry dusted wheat should require no alteration in the drill setting unless the rate of seeding is 6 pecks per acre or less, in which case it would not be amiss to increase the rate of seeding by 1 peck per acre. Dry dusted seed is not likely to cause injury to the drill even after it has remained in the drill for several days, unless the drill is allowed to stand out in dew or rain so that the seed becomes wet. However, under the conditions of these experiments wet undusted seed caused more difficulty than wet dusted seed.

Drill trouble undoubtedly can be avoided by not allowing grain to stand in drills in the open for long periods, especially in rainy weather. If this does occur, however, care should be taken to stir the grain thoroughly before sowing and to loosen the gears by rocking the drill wheel back and forth by hand. In the drill with external force feed the feed gates should be opened to remove the grain that may be caked about the feeding gears. It is important that the drill bearings be oiled frequently when dusted wheat is being sown, especially in wet weather.

**Irrigation Water Requirement Studies of Citrus and Avocado Trees in San Diego County, California, 1926 and 1927,** S. H. Beckett, H. F. Blaney, and C. A. Taylor (California Station (Berkeley) Bulletin 489 (1930), pp. 51, figs. 15).—This is the first of a series of reports of investigations on the economic field duty of water in southern California, conducted cooperatively by the station, the U.S.D.A. Bureau of Public Roads, and the California State Department of Public Works.

The results indicate that the winter water requirements of citrus groves in northern San Diego County in which cover crops of vetch or grass and weeds are grown vary from 8.6 to 12 acre-inches per acre, depending upon the size of the trees and condition of the cover crop. In the areas of northern San Diego County covered by this report, normal rainfall, when properly distributed, is adequate to meet the winter needs of both trees and cover crops. Periods of drought of more than six weeks' duration during the winter, even if preceded by heavy rains, will under conditions of cover cropping require an application of irrigation water.

Analysis of rainfall records at Escondido and Fall Brook shows that, because of deficiency in seasonal rainfall or lack of normal distribution, in at least 3 years out of 10, 1 winter irrigation, and in 2 years out of 10, 2 winter irrigations, should be provided to meet normal winter requirements of trees and cover crops. With 60 per cent efficiency in irrigation, and with 90 to 100 per cent of the soil mass moistened at each irrigation, mature citrus groves in the Escondido and Fall Brook areas have a net seasonal summer irrigation requirement of 18 acre-inches of water per acre. Similar groves in the Vista area under similar conditions require at least 15 acre-inches per acre. In fully mature groves where smaller quantities than these are available and where furrow irrigation is practiced, a correspondingly smaller percentage of the soil mass should be moistened at each irrigation. Citrus groves 6 to 8 years of age and 40 to 50 per cent of their probable ultimate size will have a net seasonal summer water requirement of 6 to 8 acre-inches per acre.

In the Sierra and Holland sandy loams 4 to 6 feet deep, the interval between irrigations should not exceed 45 days. As the depth of soil becomes less, the interval should be shortened, soils of 2 to 3 feet in depth requiring irrigation every 30 to 35 days, with smaller amounts of water applied at each irrigation.

In properly laid out groves on rolling topography, and where care is used in the application of water, 60 per cent of the water delivered to the grove should be accounted for in soil-moisture increase in the soil mass occupied by the major rooting system of the trees. As long as the soil moisture is above the wilting point, the moisture content has no measurable effect on the rate of moisture extraction; that is, moisture is as readily available when the moisture content is one-third or two-thirds of the way between field capacity and the wilting point as it is in the thoroughly moistened soil after irrigation. In the experiments thus far completed, indications are that when the available moisture in the unirrigated portions of the soil has been exhausted, there is no apparent increase in the rate of extraction from the irrigated portions; and when the available moisture in the top foot of soil has been exhausted there is no increase in the rate of extraction from the lower depths.

Some evidence was obtained from the Hinrichs grove at Escondido that the quantity of water used by citrus trees may be to some extent dependent on the percentage of soil mass moistened. While this is contrary to previously accepted principles, the evidence referred to seems to warrant further investigation.

In mature citrus groves in soils 5 feet or more in depth, an average of not more than 5 per cent of the moisture extracted was taken from the fifth foot, the mature trees having a greater range of root activity than is found in the partly matured groves. In soils less than 3 feet in depth, 50 to 60 per cent of the root activity is in the top foot of soil. Under the same soil conditions a greater apparent moisture absorption by roots is found in the lower soil depths with avocados than is found with citrus.

**[Agricultural Engineering Investigations at the Indiana Station]** (Indiana Station (LaFayette) Report 1929, pp. 8-12, figs. 4).—Studies of the use of windrow pick-up attachments for the combine indicate that the swathing method of harvesting will overcome the hazard of combining weak-strawed grain such as oats and barley. This method also makes possible the elimination of green material from the grain when combining weedy crops or those containing sweetclover. Oats combined from the windrow had an average moisture content of 10.3 per cent, while that combined direct contained an average of 14.8 per cent moisture. Records indicate that 135 acres or more must be harvested annually to make combining more economical than using the binder and thresher.

On the Paoli experimental field having terraces with a fall of 0.3 feet or less per hundred in the flow line, the rate of run-off was not sufficient to keep the flow line clear. Soil washed into the flow line retarded the flow of the water sufficiently to cause it to break over the terrace. Terraces with steeper gradients gave the water sufficient velocity to keep the flow line clear.

A hot water heating system in an insulated 16-foot shed roof poultry house maintained a temperature above 40 F throughout the winter, while temperatures in the check pen, a standard uninsulated house, got as low as 2 F. The relative humidity in the heated pen varied from 25 to 45 per cent, while that in the check pen fluctuated with the outside weather conditions, averaging approximately 85 per cent. Production in the insulated but unheated pen was slightly higher throughout the season than in either the heated pen or the check pen.

Fifty per cent more current was used by electric brooders with overhead heat than by one of the underheat types, although the mortality was approximately the same for both types. The cost with electric current at 3 cents per kilowatt-hour is greater for electric brooders than for hard coal heated ones (hard coal at $16 per ton), with the mortality the same for both types of fuel.

A two-roll husker-shredder can be satisfactorily operated by a 5-horsepower electric motor. The capacity of the machine when increased by a 7.5-horsepower motor does not increase in the ratio of the power increase. A four-roll husker can be operated by a 7.5-horsepower motor but with very limited capacity at its rated motor horsepower.

Electric illumination used two hours daily during November and December increased the growth of Grand Rapids leaf lettuce approximately 15 per cent. At a cost for current of 3 cents per kilowatt-hour the cost of lettuce was 24.9 cents per pound.

Figures reported from a survey conducted among feed grinder owners indicate that excessive overhead may be incurred in the purchase of large grinders where the annual grinding consists of a few hundred bushels. Smaller grinders operated over a longer period of time reduce overhead costs which must be included in the cost of grinding. The results of tests conducted on the grinding of oats to different degrees of fineness show that the power cost increases rapidly as fineness increases. Four to 6 times as much power is required to grind oats through a 1/16-inch screen as through a ¼-inch screen.

**Milk Cooling on California Dairy Farms,** B. D. Moses and J. R. Tavernetti (California Station (Berkeley) Bulletin 495 (1930), pp. 34, figs. 15).—This bulletin is a contribution from the station and the California Committee on the Relation of Electricity to Agriculture. It discusses the so-called wet and dry types of mechanical milk-cooling systems, and reports the results of tests.

These results indicate that when the milk is cooled and stored in 10-gallon cans, the brine system being used, about 0.12 kilowatt hour is consumed per gallon of milk. When the milk is cooled and stored in bottles, the brine system being used, 0.17 kilowatt hour is consumed per gallon of milk. When the milk is cooled and not stored, the brine system being used, about 0.09 kilowatt hour is consumed per gallon of milk. When cooled and stored or not stored, the direct expansion system being used, about 0.05 kilowatt hour is consumed per gallon of milk.

Estimating electric power at 2 cents per kilowatt-hour, depreciation at 10 per cent, interest at 7 per cent, and upkeep at 3 per cent per annum, a milk-cooling plant will cost from 0.5 to 1 cent per gallon cooled, depending on the size and type of plant and the method of handling the milk.

If a storage box is needed, a floor space of 15x15 inches should be allowed for each 10-gallon container that is to be stored. Where the milk is stored in quart bottle cases, a space 16x20x12 inches should be allowed for each case. The equivalent of 3 to 4 inches of sheet cork should be used for insulation of the brine tank or storage box. If the brine system is used the tank should contain from 1.5 to 2 gallons of brine for each gallon of milk cooled per day. A 0.5-inch centrifugal brine pump driven by a 0.25-horsepower motor is sufficient for circulating the brine where less than 200 gallons per day are cooled. A 0.75-inch centrifugal pump driven by a 0.25-horsepower motor is sufficient where 200 to 400 gallons of milk are cooled per day. The aerator should be of the two-way type, with water passing through the upper half and brine through the lower half. Approximately 6 inches of horizontal length should be allowed for each 10 gallons of milk cooled per hour.

The milk should be cooled to about 10 F below the temperature at which it is to be delivered to the distributing plant. About 40 F is the usual desired temperature of cooling over the aerator. The storage box temperature should be kept a few degrees lower than the temperature to which the milk is cooled.

## Book Reviews

**"Manual on Research and Reports"** is a recent volume issued by the Committee on Research, The Amos Tuck School of Administration and Finance, Dartmouth College. It covers the procedure of scientific investigation and presentation of material from the definition of the problem to proof reading of the typewritten manuscript, with special application to investigations in the fields of business, economics and public affairs. As stated in the foreword "The Manual is not a substitute for training in scientific method or in writing, but is merely a selection of helpful suggestions gleaned from the experience of members of the Tuck School faculty and others having knowledge in this field." Its chapters cover "Laying the Groundwork," "Gathering Information," "Recording and Organizing Information," "Analyzing and Interpreting the Data," "Preparing the Manuscript," "Anatomy of a Report," and "Guarding Against Error." General guides to information and to state and federal statistical work are included in appendices. A bibliography and an index are included. This book should prove helpful to anyone who has occasion to conduct and prepare reports on any investigations. Williams and Wilkins Co., Baltimore. $1.25.

**Preparation of Scientific and Technical Papers"** by Sam F. Trelease, professor of botany, umbia University, and Emma Sarepta Yule, head of the department of English, College of Agriculture, University of the Philippines, is a manual of information on what the authors consider the best practice in arranging technical information and preparing it for publication. Matters covered include the form and arrangement of subject matter; use of tenses, abbreviations, names of plants and animals, tables, and footnotes; and suggestions and technique applying to the author's part in the accomplishment of the desired printing results. The present issue is a 1930 reprint of the second edition. Williams and Wilkins Co., Baltimore. $1.50.

**"Farm Machinery Laboratory Manual,"** by D. Scoates, professor of agricultural engineering, A. and M. College of Texas, has recently been published by him in the seventh edition. It is a paper-bound, 6x9-inch volume containing 49 laboratory exercises designed to give agricultural students in agricultural colleges the understanding of farm machinery necessary to its proper selection, care and operation. The exercises deal largely with field machinery.

**"Farm Gas Engine and Tractor Laboratory Manual,"** by D. Scoates, professor of agricultural engineering, A. and M. College of Texas, has recently been published by him in the fourth edition. It is a paper-bound 6x9-inch volume containing 22 laboratory exercises designed to familiarize agricultural students in agricultural colleges with the principles involved in farm gas engine and tractor operation. Twelve of the exercises are devoted to gas engines, including one exercise on farm electric light plants. The remaining ones are on tractors.

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# AGRICULTURAL ENGINEERING

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## Engineering Basis for Reorganization

STATEMENTS that agriculture must be reorganized are legion. And progressive farmers, farm managers, agricultural scientists, business leaders and government officials are looking to agricultural engineers to do everything in their power to bring about that reorganization as quickly and as painlessly as possible.

What agricultural engineers have already done to reorganize agriculture, by way of making available improved farm machinery, materials and methods is but half of their job. Some farmers have been able to use these improvements to fairly good advantage. They have had a taste of the benefits of modern equipment and methods and are hungry for more. But on a farm or in a factory a miscellany of inherently good equipment, materials and methods will not assure efficient production. Efficient production can come only from an establishment which is in itself an organized, integral unit, with all its parts functioning in a coordinated way toward the realization of a common objective.

Our conception of the reorganized agriculture which will bring the desired improvement in the economic and social welfare of farmers is one in which the farms are definitely designed as production plants; are "tooled up" for production as carefully as any industrial plant; and all operations are conducted in accordance with sound engineering and business principles.

Some of the leading farm managers of the country are approaching their work from this viewpoint; and finding a lack of engineering information needed to plan, equip for and carry out an agricultural production program with the efficiency they believe it possible to achieve.

They need more production cost figures on specific commodities which might have a place in their production programs; figures itemized in detail with a view to possible cost reductions, showing the connection between the cost of each operation, its functions, methods used, working conditions and power, labor, fuel, depreciation and other cost factors. They lack information on the work and equipment requirements of various phases of a production program which makes it difficult for them to coordinate their operations so as to minimize peak loads, waste motion, etc. They are constantly faced with the problem, in directing the expenditure of funds, of deciding which branches of their business, which operations, which repairs, which improvements, or which additional pieces of equipment will yield the highest returns on the money which is or might be made available. There is little information on the actual cash value of an additional acre, a terrace or tile, a new barn, a new stable floor, new tractor or what not under a variety of specific conditions, which a farm manager can use as a guide in directing his expenditures and investments.

Where can a farm manager go for information that will help him to make his production program as flexible as possible without running up his equipment overhead; that will show him how much high-efficiency, special production equipment he can use and still maintain a satisfactory load factor; that will enable him to reach the best compromise between low machinery investment and machine capacity sufficient to perform necessary operations at the proper time. He should be able to go to agricultural engineers for this help.

Other lines of agricultural engineering research must continue, but to enable farmers to cash in to the fullest extent on agricultural engineering progress up to the present, we need to give particular attention to studies of individual operations, individual equipment performance, and individual commodity production costs; of combinations of operations, equipment, and fixed improvements, which might be followed in actual farm practice; and of the relation of these things to net return. Just a few examples of such research which has been done in the past are Aginsky's work on the number of tractors required on a given size and type of farm, McKibben's study of factors determining the effective capacity of field machines, Stahan's compilation of figures on the relation of milk production cost to income from high and low-producing cows, and H. B. White's study of chore routes in dairy barns. It is studies like these that will give rise to engineering principles and standards for planning, equipping, and operating farms with higher efficiency than is achieved at present; that will release to farmers the full benefits of all agricultural engineering work and make possible a thorough reorganization of agriculture.

## Progress in Rural Electrification

RURAL electrification has been under way long enough that its progress is being measured in various ways. W. T. McCaskey, manager of the rural service department of the Middle West Utilities Company, has compared rural electrification progress with electrical progress in other directions as follows:

"The extension of electric service to the farms of this country is going forward at a more rapid pace than has any other major power development in the history of the electric industry. In its extension and application to the farms and rural districts generally, it is simply repeating or continuing the history and practice along other lines incident to the industry since its inception. Therefore, the main problems pertaining to extension and application of electric service to the farms differ only in minor detail from the problems past and present of the industry as a whole; the principal difference being that we have today a much fuller and broader fund of information available regarding the proper application of electrical devices to farm service than we had for application to other uses during corresponding periods of development."

Mr. McCaskey thus gives tribute to those responsible for the increasing application of electricity in agriculture, without naming them. They are those who conceived the national Committee on the Relation of Electricity to Agriculture and the corresponding state committees; who support and contribute to the work of these committees; and who direct and carry out their work.

We are proud of the fact that agricultural engineers have been connected with the work from the start; have given it the benefit not only of their viewpoint and technical ability, but of their engineering spirit of cooperation, helpfulness and devotion to progress.

# A.S.A.E. and Related Activities

## Anniversary Meeting Plan Developments

IN THE orderly development of A. S. A. E. annual meeting plans (Iowa State College, Ames, June 22-25) under the able direction of H. B. Roe, chairman of the Meetings Committee, and J. B. Davidson, chairman of the Committee on Local Arrangements, some additional progress and some minor changes have been made since the general outline of the program was announced last month.

The College Division session has been shifted from Tuesday afternoon to Monday forenoon. Monday afternoon and Tuesday have been left available for technical sessions of the technical divisions. These divisions have been making progress in arranging their respective programs but have as yet made no definite announcement as to subjects or speakers.

"Anniversary Day" will be Wednesday, June 24, as previously announced and will, by appropriate addresses, a pageant of agricultural engineering progress, and the annual dinner of the Society, focus attention on the growth and development of agricultural engineering, the present status of the profession, and its outlook for the future. Arrangements are being made for addresses presenting an agricultural viewpoint on the application of engineering in this field, a history of the development of tillage and harvesting machinery, the philosophy of agricultural engineering and some significant aspects of some of the technical branches of agricultural engineering, in addition to the address of welcome and the president's annual address. The same high standard in addresses of universal interest will be maintained in the general session scheduled for Thursday morning.

In selecting the general session subjects and outstanding speakers every effort is being made to obtain a balance between representatives of agriculture, science and engineering; of industry and of public institutions; of teaching, extension and research; and between the several technical branches of agricultural engineering.

Three prominent A.S.A.E. members are already definitely scheduled to present inspirational addresses on the general sessions program. J. B. Davidson, a member of the Meetings Committee, has been drafted by other members of the Committee, because of his generally recognized position in the profession, to give the address on "The Philosophy of Agricultural Engineering." James A. King, agricultural engineer for the Mason City Brick and Tile Company, will deliver a keynote address of similar nature with particular reference to land reclamation. B. B. Robb, professor of agricultural engineering, Cornell University, has agreed to address the Society on "The Function of the Extension Engineer in the Reorganization of American Agriculture."

Thursday afternoon, June 25, the final afternoon of the meeting, has been reserved for a trip to the plant and farm of the Meredith Publishing Company, at Des Moines. The Company has invited the Society to make the trip from Ames to Des Moines and return in chartered busses, to inspect their publishing plant and have supper on their farm, all entirely free of charge. As the Company is one of the leading agricultural publishing houses and is actively interested in promoting the application of engineering to agriculture, the Meetings Committee gladly accepted for the Society the rare opportunity offered.

The College Division program the first morning, brief and to the point; the succeeding three half-days of simultaneous technical sessions devoted to current problems and progress in each of the leading technical branches of agricultural engineering work; followed by a day and a half of general sessions for consideration of the economic, social and professional significance of agricultural engineering, past, present and future; rounded out with the annual dinner, business meeting, group conferences and opportunities for business, professional and social contacts; and concluded with a fine inspection trip, will combine to give agricultural engineers greater inducement to attend than ever before.

## College Division Advisory Committee Meets

S. P. LYLE, agricultural engineer, U.S.D.A. and chairman of the College Division of A.S.A.E., brought the Advisory Committee of the Division together in Washington, March 9, 10 and 11, for its usual annual meeting.

The Committee meets once each year to consider and make recommendations on a wide variety of suggestions, proposals and developments affecting agricultural engineering education, extension and research, and the development of the profession.

Members of the committee at present, in addition to Chairman Lyle, are F. C. Fenton, professor of agricultural engineering, Kansas State Agricultural College, C. E. Seitz, professor of agricultural engineering, Virginia Polytechnic Institute, E. E. Brackett, professor of agricultural engineering, University of Nebraska, and D. G. Carter, professor of agricultural engineering, University of Arkansas. A limited number of other A.S.A.E. members who find it possible to do so and who are particularly interested in some of the subjects to be discussed usually sit in on the meetings. Detailed report of discussions and recommendations made at the meeting this month have not yet been received.

## Pacific Coast Section to Consider Large-Scale Farming

LARGE-SCALE farming is slated to receive the attention of the Pacific Coast Section of A.S.A.E. at a spring meeting to be held on the campus of the University of California at Berkeley on Friday, May 1. This was decided by the Section's Executive Committee at a meeting February 20. Those present were Major O. V. P. Stout, chairman; H. E. Murdock, vice chairman; W. L. Paul, past chairman; and W. W. Weir, secretary.

Considering favorably a previous suggestion by R. E. Storie, associate in soil technology survey, University of California, the committee decided that large-scale, industrial, group, corporation and contract farming should be studied at the meeting, from six different viewpoints, namely, those of the large owner, small owner, farm manager, banker, equipment industry, and economist. Speakers to present the several viewpoints have not yet been announced.

The meeting will be concluded with a modestly priced evening banquet to which the members are invited to bring their wives.

## Police Raid Research Project

SMOKE issuing from an orange grove near Pomona, California, between 4 and 5 o'clock in the morning, and the muffled sound of men working there recently led local police to conclude that they had located some "alky" manufacturers pursuing their nefarious calling.

A heavily armed squad surrounded the scene of activities, closed in, and ordered the men into arrest. The leader of the gang, however, after debating for a while and showing his equipment, was able to convince the police that he was A. H. Hoffman, research agricultural engineer of the University of California, and that he and his helpers were merely conducting some investigations on the effectiveness of orchard heaters.

## Agricultural Engineers in on Nebraska Engineers' Roundup

FOUR prominent agricultural engineers and members of A.S.A.E. contributed to the success of the Nebraska Engineers' Roundup held at Lincoln, February 25, to call the attention of the state's engineers and general public to "The Significance of Engineering to Nebraska."

J. B. Davidson, professor and head of the department of agricultural engineering, Iowa State College, was the speaker for the banquet held in the evening at Hotel Lincoln. His subject was "The Engineer's Responsibility to Society."

"Engineering on the Farm and in the Rural Communities of Nebraska" was the subject presented at the opening of the afternoon program by I. D. Wood, extension agricultural engineer, University of Nebraska.

R. N. Towl, drainage engineer of Omaha and E. E. Brackett, professor and head of the department of agricultural engineering, University of Nebraska, served on the general committee responsible for the meeting. Mr. Towl also served on the finance committee and Mr. Brackett on the dinner committee.

## Standards Adopted

BY AN almost unanimous vote A.S.A.E. members have adopted as A.S.A.E. standards and recommended practices the proposed standard and recommended practices on power take-off for agricultural tractors and machines and the proposed standard disk blades for disk plows, harrows, drills, listers and cultivators, as published in AGRICULTURAL ENGINEERING for January.

The power take-off standards and recommended practices are being reprinted and given wide distribution with a view to securing general adherence among the tractor and drawn-tool manufacturers.

A number of suggestions for revision of the disk blade standards have been received and it is probable that a meeting of engineers of the companies interested will be called in the near future to give consideration to the proposed changes.

## Necrology

**Milton H. Hoffman,** a member of A.S.A.E. from 1916-1924, passed away at his home in Eldridge, Iowa, February 1. After graduating from Iowa State Teacher's College and teaching in the public schools of Iowa for a number of years he attended Iowa State College, earned his bachelor's degree in agricultural engineering, was retained on the agricultural engineering faculty of that institution, in a few years was made extension professor of agricultural engineering and held that position until in 1920 he resigned to become county agricultural agent of Scott County, Iowa. At the time of his death he was a representative of the American Farmers' Mutual Life Insurance Company, which is associated with the Iowa farm bureau federation. In the many different positions which he filled he was always a popular, active leader with a strong interest in his fellow men and great capacity and willingness to work unselfishly for them.

## A.S.A.E. Meetings

**Pacific Coast Section,** spring meeting, University of California, Berkeley, Friday, May 1. General subject—Large-Scale Farming.

**Twenty-Fifth Anniversary Annual Meeting,** Iowa State College, Ames, Monday, June 22 to Thursday, June 25.

## Personals of ASAE. Members

**A. D. Edgar,** extension agricultural engineer, Michigan State College, has resigned that position, effective April 1, to join the division of agricultural engineering in the U.S.D.A. Bureau of Public Roads, where he will be engaged in farm structures research. He will be located in Washington temporarily.

**L. J. Smith,** secretary and **Harry L. Garver,** investigator for the Washington State Committee on the Relation of Electricity to Agriculture are joint authors of "A Progress Report of Investigations" for the year 1930. Some of the interesting projects covered are "All Night Lighting of Laying Houses," "Soil Heating Investigations," "Elevating Grain," "Home Economics Studies," "Sprinkler Irrigation in Orchards," "Irradiation of Dairy Feed and Cows' Udders with Ultra-Violet Light," and a "Non-Stop Pump Test."

## Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the February issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

**W. D. Collins,** power farmer, Fullfords, Sussex, England.

**R. G. Ferris,** research engineer, Starline, Inc., Harvard, Ill.

**H. O. Hill,** junior civil engineer, U. S. Department of Agriculture, Tyler, Tex.

**J. H. Hough,** rural electrification engineer, Baton Rouge Electric Company, Baton Rouge, La.

**Frank W. Hussey,** junior partner, Chas. E. Hussey & Sons, Presque Isle, Me.

**Adolphe LeBron,** project engineer, United Fruit Company, Puerto, Castilla, Honduras, C. A.

**G. A. Mitchell,** agent, Bureau of Public Roads, Magnolia Road, Vineland, N. J.

**O. W. Monson,** assistant professor in agricultural engineering, Montana State College, Bozeman, Mont.

**L. S. Wing,** engineer, California Farm Bureau Federation, San Francisco, Calif.

### Transfer of Grade

**E. G. Johnson,** extension agricultural engineer, University of Illinois, Urbana, Ill. (Junior to Associate Member.)

## New ASAE. Members

**Arthur King,** extension specialist in soils, Oregon State College, Corvallis, Ore.

**Macy H. Lapham,** senior soil scientist, U. S. Department of Agriculture, Berkeley, Calif.

## EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

### Men Available

AGRICULTURAL ENGINEER desires position as manager of an agricultural enterprise or with agricultural implement manufacturer. Has had 15 years experience in the development of large-scale farming operations including both irrigation and drainage. College degree. MA-186.

AGRICULTURAL ENGINEER, with master's degree in electrical engineering and master's degree in agricultural engineering and with two years experience in rural electrification work in a western state college and one year in rural service work with an electric power company, and now employed in the rural service department of a power company, desires permanent connection either in research work in a college or in the rural service department of an electric utility or appliance company in the far west. Age 24. Good health. Married. MA-194.

AGRICULTURAL ENGINEER with degree from Iowa State College 1925 and special work in farm structures desires to make change to more active work. Has several years experience in farm structures work with barn equipment concerns. Interested in making a connection with building materials manufacturer or promotion association, experimental station with state college, or barn equipment manufacturer. Age 38. Married. Location in Middle West preferred. MA-195.